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Working Paper

MANPRINT FINDINGS FROM THE FOLLOW-ON OPERATIONAL TEST AND EVALUATION OF THE AN/TRC-170(V)
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INTRODUCTION

Purpose of Test

The Follow-On Operational Test and Evaluation (FOT&E) of the AN/TRC-170(V) Tropospheric Scatter Radio Terminal Set was conducted to provide data concerning Reliability, Availability, Maintainability (RAM), logistical and training requirements, operational effectiveness, performance, transportability and interoperability. The AN/TRC-170(V) FOT&E test data and previous multi-service testing will support a fielding decision at an Army In-Process Review (IPR).

Scope:

The FOT&E was conducted at Fort Huachuca and in the southern half of the state of Arizona between September-December 1986 to collect data related to the test Issues and Criteria. Issues had been identified in the functional areas of Reliability, Availability, and Maintainability (RAM), Logistic Supportability, Training, Transportability, and Interoperability. The MANPRINT area was also investigated and data collected to answer relevant MANPRINT issues for the system under test. The test was conducted in three phases: Training, Pilot Test, and Record Test. TRADOC-approved scenarios were tactically employed to depict an environment which would be expected in the field.

BACKGROUND

The AN/TRC-170(V) Tropospheric Radio System is a key transmission system in the TRI-TAC family of equipment. In September 1972 a demonstration and validation test was performed for the government by the contractor (Raytheon Corp.) In June 1976, the full scale engineering development (FSED) model became available and was the equipment on which the USAF performed a joint Developmental Test and Evaluation (DT&E) and Initial Operational Test and Evaluation (IOT&E) from December 1979 to October 1980. In January 1981, the U.S. Army began limited procurement of two models of the AN/TRC-170(V), the V2 and V3. At this time, fixes were made for the limitations identified in the USAF DT&E/IOT&E, and they were incorporated into what is now the production model. The U.S. Army Operational Test and Evaluation Agency (USAOTEA) was tasked to conduct a FOT&E of the production model AN/TRC-170(V) in the September - December 1986 time frame.

AN/TRC-170(V) Description

The AN/TRC-170(V) is a Tropospheric Scatter Radio Terminal Set used for secure voice, data and record traffic, multichannel, and extended range communications. The AN/TRC-170(V) series consists of two tactical digital Troposcatter Radio Terminals, (V)2 and (V)3, which provide secure multichannel transmission and reception of analog and digital traffic for a Corps and Echelons Above Corps (EAC) area of operation. The AN/TRC-170(V)2 (S-280 shelter) is mounted on a wheeled mobilizer and towed by a 2 1/2 ton truck. It has a planning range of 150 miles and operates in quad diversity. The AN/TRC-170(V)3 (S-250 shelter) is transported on a 2 1/2 ton truck. It has a planning range of 100 miles, due in part to the smaller Quick Reaction Antenna (QRA) and operates in dual diversity. At Corps level the AN/TRC-170(V) will be used to support contingency corps operations, and extended range communications. Six AN/TRC-170(V)2 models and and four AN/TRC-170(V)3 models were utilized during the FOT&E.

Concept of Employment

The AN/TRC-170(V) FOT&E utilized the first unit equipped (FUE) 526th Heavy Tropo Company, 86th Signal Battalion, 11th Signal Brigade, USAISC, Ft. Huachuca, Arizona. The unit received an operations order to deploy to the field as they would when given a tactical mission, IAW test unit SOPs. The operations order called for the implementation of 11th Sig Bde field SOP's. Ten AN/TRC-170(V) terminals were deployed in pairs occupying up to five tactical sites, at any one time, in southern Arizona. Each of the AN/TRC-170(V)s deployed to a new site approximately every 96 hours. The ten terminals moved a total of 104 times. Movement of the terminals took place under both day and night conditions. The FOT&E utilized TRADOC approved tactical scenarios designed to provide data related to the test issues and criteria. Scenarios provided for secure, digital, multi-channel communications links simulating support to HQ elements within a Corps and Echelon Above Corps (EAC) area of operations. The scenarios represented the planned employment of the AN/TRC-170(V), running 24 hours per day for a 96 hour mission, in accordance with current doctrine. Three networks were used during Phase III (Record Test) of the FOT&E: Network One simulated a Corps Nodal Network for Interoperability testing. Network Two simulated a Skip Node (Radio Relay) operation. Network Three was similar to Network One; however, most of the terminal devices were replaced by the Traffic Loading Device (TLD) and the Automated Experimental Measurement System (AEMS) van for automated data collection. No threat, Electronic Warfare, or Nuclear, Biological, Chemical (NBC) tactics were employed against the AN/TRC-170(V) systems as these had been accomplished in prior testing.

Doctrinal Employment

The AN/TRC-170(V) systems are deployed to support contingency Corps operations in areas requiring extended range communications links. Because of the nature of contingency operations, the area of operations is normally much larger than a doctrinal corps and use of TROPO may be required to install long haul communications systems. Light and heavy Tropo companies are deployed as required to support or reinforce the contingency corps. Both (V)2 and (V)3 tropo terminals are employed at EAC to meet the needs of the Theater Communications Command (Army) (TCC(A)). Additionally, all of the system planning factors should be taken into account in determining if a given AN/TRC-170(V) system should be employed in the TROPO mode, or the LOS mode. These factors include, but are not limited to, radio link distance, acceptable Bit Error Rate (BER), number of circuits required, terrain to be traversed, and the proximity of enemy intercept or jamming systems. The tactically-oriented, digital tropo terminals are utilized at EAC for the following applications:

a. Line of Communications (LOC) Interconnect Node.
b. Extension of the existing Defense Communications System (DCS).
c. Skip Node Operations.
d. Contingency Operations.
e. Extension or restoration of US/Allied Communications Systems.
f. Major Headquarters Connectivity to include Allied/Host Nation.
g. Pershing Communications.

TEST ISSUES

Performance.

Does the AN/TRC-170(V) perform its mission as well as or better than those systems it is intended to replace?

This issue was addressed through an evaluation of the mission performance attributes of the AN/TRC-170(V) as compared to those demonstrated by the Radio Terminal Sets it will replace once fielded. The following list of equipment is scheduled to be replaced on a one-for-one basis by the AN/TRC-170.

Current item	Replaced by
AN/TRC-132	V2
AN/TRC-132A	V2
AN/TRC-112	V3
AN/TRC-121	V3

Recognizing the limited availability of currently fielded equipments for testing, a representative data sampling of at least one heavy TROPO system (i.e., AN/TRC-132) was acceptable to address this issue. Additionally, subjective comments and opinions were obtained from user personnel (operators and maintainers) to serve as a point of departure in such area as MANPRINT, Logistics, Transportability and RAM assessment.

RAM

Does the AN/TRC-170(V) provide a sufficient level of Reliability, Availability and Maintainability (RAM) in an operational environment to meet mission performance requirements?

Reliability, Availability, and Maintainability were measured under operational conditions following the operational mission profile. Areas in which high failure rates and modes were experienced during IOT&E were examined to determine if the predicted failure reductions have been achieved. Investigative assessments were also made to determined if any new failure modes had been introduced as a result of fixes/improvements to the AN/TRC-170(V).

ATACS/TRI-TAC Interoperability

Does the AN/TRC-170(V) equipped with an Army Tactical Communications Systems (ATACS) modem interoperate with ATACS and other TRI-TAC equipment in an operational environment?

An assessment was made of the adequacy of the AN/TRC-170(V) to interoperate, at 576 kbs family rates, with selected ATACS, Improved ATACS, and TRI-TAC equipments. Both secure/nonsecure telephone, teletype, and data traffic were electrically transmitted throughout a hybrid (analog and digital) communications network to evaluate the capabilities of the AN/TRC-170(V) and acceptability of traffic. Equipment interfaces between the AN/TRC-170(V) and other equipments were also examined to determine if it is necessary to modify equipment or procedures to achieve satisfactory interoperability.

DGM Hybrid Interoperability

Can the Digital Group Multiplexer (DGM) assemblages (AN/TRC-173, AN/TRC-174, AN/TRC-175, and AN/TRC-138A) successfully interoperate with ATACS equipment and other TRI-TAC equipment in an operational environment? This issue is related to the interoperability aspects of DGM equipment with a hybrid network.

An assessment was made of the adequacy of the DGM assemblages to interoperate with all the intended ATACS and TRI-TAC equipment available during the AN/TRC-170 FOT&E. DGM equipment was employed in each scenario which was doctrinally acceptable for their inclusion. Equipment interfaces were examined to determine the existence of any deficiencies in procedures and documentation or physical incapabilities which either hinder or prevent DGM employment.

Logistics - Concept

Does the logistics concept meet operational needs in a tactical environmental?

This issue assessed the adequacy of the logistics concept at all maintenance and supply echelons. Due to test limitations, maintenance and supply was only evaluated through the organizational level.

Logistics - Tools

Do the tools, test equipment, spare and repair parts meet the operational needs in a tactical environment? (Human Factors - MANPRINT).

This issue assessed the adequacy of special and common tools, TMDE, spares, and repair parts stockage at all maintenance and supply echelons. Due to test limitations, maintenance and supply was only evaluated through the organizational level.

Logistics - Personnel

Do the operator and maintenance personnel assignments meet the operational needs in a tactical environment? (Human Factors - MANPRINT).

This issue assessed the adequacy of operator and maintenance personnel assignment at all echelons. Due to test limitations, maintenance and supply was only evaluated through the organizational level.

Logistics - Publications

Are technical publications adequate to operate and maintain the AN/TRC-170(V)? (Human Factors - MANPRINT).

Technical documentation was examined to determine if the technical, operator, and maintenance manuals provide operating and maintenance personnel with the information necessary to operate and maintain the equipment. The technical publications were assessed for accuracy and completeness of information, applicability for use at intended skill levels, handling, durability, ease of access and update, and the accommodations of changes and modifications to the data during testing.

Training

Does the training program adequately prepare typical user personnel to perform tasks required to utilize, operate, and maintain the AN/TRC-170(V) in an operational environment? (Human Factors - MANPRINT).

The issue assessed the training of personnel who install, operate, maintain, and manage the AN/TRC-170(V). Training topics assessed included set-up, teardown, configuration, operation, troubleshooting, repairs, and maintenance at the unit and organizational levels. Due to test limitations, maintenance and supply was only evaluated through the organizational level.

Transportability

Can the AN/TRC-170(V) be successfully transported for tactical and strategic deployment?

The transportability, to include cross-country, of the AN/TRC-170(V)3 was assessed to determine if ground and air means are adequate. Air, rail, and sea upload was not tested.

MANPRINT

Can the personnel resources and capabilities provided support AN/TRC-170(V) throughout its lifecycle?

This issue includes aspects of all prior issues. The MANPRINT approach details the analysis into six categories as follows:

1. Manpower
2. Personnel
3. Training
4. Human Factors Engineering
5. System Safety
6. Health Hazards Assessment

TEST LIMITATIONS

Contractor Maintenance. The FOT&E employed contractor personnel to perform maintenance above the organizational level (IDS, IGS, and Depot) due to the maintenance concept not being fully implemented. The impact was that the maintenance/logistic supply system was not fully tested.

Lack of Radio. The AN/GRC-193A High Frequency (HF) Radio, used for command and control purposes, was not available for the FOT&E due to the AN/TRC-170(V) not ranking high enough on the priority list for the item. Scheduled availability is the 1990 time frame. The MSR-8000 HF radio was substituted in its place. The HF radio was used as both an engineering orderrwire (as needed) and for command and control purposes. (NOTE: The MSR-8000 was a test unit asset which is normally dedicated to other missions, but was available during the FOT&E.) The impact is that data was not collected on the AN/GRC-193A HF radio system.

Prime Mover Unspecified. The M35A2 2 1/2 ton truck was used as the substitute prime mover for the (V)3. The official prime mover has not yet been identified. The M35A2 will not allow the (V)3 to be transported by C-130/141 aircraft. The impact was that no data was able to be collected on the official prime mover during testing.

Loop Rate. Only the 32 kilobyte/per second (Kb/s) loop rate was utilized during the FOT&E, whereas the Joint IOT&E, conducted December 1979 through October 1980, used the 16 Kb/s loop rate. There was no significant impact.

Electronic Warfare. No EW threat environment was tested against the AN/TRC-170(v). EW was evaluated in previous testing. There was no significant impact.

NBC. No actual Nuclear, Biological, Chemical (NBC) agents threat were tested against the AN/TRC-170(V). However, tactical scenarios requiring the wear of Mission Oriented Protective Posture (MOPP) IV (clothing, mask, boots and gloves) were utilized. (NOTE: Limited NBC was evaluated in previous testing using MOPP IV gear under simulated conditions). There was no significant impact.

AN/TTC-38. This was unavailable for interoperability testing, due to USMC requirements for the equipment. There was no significant impact as other analog and digital switches were used (AN/TTC-39, AN/TYC-39, AN/TTC-42, SB-3614, and SB-3865).

AB-1309. These antennas were not available with the DGM equipments, because they had not yet been approved for fielding. The impact was that the transmission media between DGM equipments was limited to cable (CX-11230).

Unavailable. The following equipments were not available for the FOT&E: TD-1065/1069, TD-202/204, AN/UXC-7, and the Single Subscriber Terminal (SST). Equipment representative of the aforementioned equipment were tested. It was assumed that there was no significant impact as the AN/UGC-137A(V)2 (SST) had been previously tested and the multiplexer interfaces have been documented. The AN/UXC-7 interface will have to be demonstrated in other testing.

Personnel records. The operator personnel test records could not be obtained during the time period of the test. No relational information is available using standard Army test results for the operator personnel.

Test materials. The operator training (Keesler Air Force Base) test results have been obtained. The actual test materials for use in retesting of the operator personnel could not be obtained for field use on this test.

METHODOLOGY

Review of Prior Tests

Reports from testing of the AN/TRC-170(V) system were reviewed to assist in determining issues to address during FOT&E testing. The review covered the following prior tests: The USAF joint Developmental Test and Evaluation (DT&E) and IOT&E from December 1979 to October 1980. In January 1981, the U.S. Army began limited procurement of two models of the AN/TRC-170(V), the V2 and V3. At this time, fixes were made for the limitations identified in the USAF DT&E/IOT&E, and they were incorporated into what is now the production model. The problems identified from these tests provided a starting point for the current test.

Review of System Documentation

The available plans and documentation for the AN/TRC-170(V) system were as follows:

Operational and Organizational Plan. The O&O plan for the AN/TRC-170 Tropospheric Scatter Radio Terminal Set, Draft of September 1985, issued by U.S. Army Signal Center and Fort Gordon, Fort Gordon, Georgia.

Test and Evaluation Master Plan. The TEMP for the AN/TRC-170 Program, issued by Department of the Air Force, Headquarters Electronic System Division (AFSC), Hanscom Air Force Base, Massachusetts, dated 15 May 1981.

Failure Definition/Scoring Criteria. The FD/SC for the Follow-on Evaluation (FOE) of the AN/TRC-170 (V2)/(V3), issued by Department of the Army, Headquarters U.S. Army Signal Center and Fort Gordon, Fort Gordon, Georgia, dated 22 November 1985.

Independent Evaluation Plan. The IEP for the Tactical Digital Troposcatter Radio Terminal AN/TRC-170(V), issued by U.S. Army Operational Test and Evaluation Agency (USAOTEA), Falls Church, Virginia, dated 18 August 1986.

Preliminary Technical Manual. (PTO 31R2-2TRC170-1) Radio Terminal Set AN/TRC-170(V)2 Part Number 951100-4 NSN 5820-01-148-3977, (FULLY VERIFIED), issued by Raytheon Company, Lexington, Massachusetts, under authority of the Secretary of the Air Force, dated 1 June 1986, updated 20 November 1986.

Preliminary Technical Manual. (PTO 31R2-2TRC170-11) Radio Terminal Set AN/TRC-170(V)3 Part Number 951100-5 NSN 5820-01-148-3976, (FULLY VERIFIED), issued by Raytheon Company, Lexington, Massachusetts, under authority of the Secretary of the Air Force, dated 1 June 1986.

TRI-TAC Equipment Interface Plan. For AN/TRC-170, written by Rene J. Dube, Jr. and Paul M. Hotzel of the Mitre Corporation (McLean, Virginia), Sponsored by the U. S. Army contract number F19628-84-C-0001, manual dated May 1985.

The documentation listed was also used as a basis for development of a MANPRINT test plan for the AN/TRC-170(V) system. The development of critical tasks and emphases for data collection were based upon these documents and manuals.

Data Collection Methods

Performance time. Performance time data was collected by Test Directorate personnel for all identified tasks. The critical task list was developed in cooperation with MANPRINT personnel, Data Management personnel, Evaluation personnel and subject to the practical resource limitations of the overall test. The tasks are as follows:

A. AN/TRC-170(V)2 Setup Tasks.

1. Azimuth Stake Out
2. Antenna Base & LPA Stake Out
3. Transit Frame Removal
4. Truss Assembly Removal
* 5. Antenna Anchors (Drilling & Setting)
6. Unloading Low Profile Pallet

First V2 Antenna

7. Base Plate Installation
8. Securing Antenna Legs
9. Installing Azimuth/Elevation (AZ-EL) assembly
10. Installing Reflector Hub
11. Installing Upper Reflector Pedals
12. Installing Roll Yoke Struts
13. Attaching Flexible Waveguides
14. Antenna erection

Second V2 Antenna

15. Base Plate Installation
16. Securing Antenna Legs
17. Installing Azimuth/Elevation (AZ-EL) assembly
18. Installing Reflector Hub
19. Installing Upper Reflector Pedals
20. Installing Roll Yoke Struts
21. Attaching Flexible Waveguides
22. Antenna erection

General Setup

* 23. LPA Erection
24. Shelter Setup (External)
25. Shelter Setup (Internal)
26. Klystron Adjustment
27. Antenna Alignment

Note. Tasks 3 & 4 are subtasks of task 6. Tasks 1-6, 23 & 24 are performed in parallel with tasks 7-22. Tasks 7-14 can be performed in parallel with tasks 15-22.

B. AN/TRC-170(V)3 Setup Tasks.

1. Azimuth Stake Out
2. Site Positioning of Trailer/Shelter
3. Unloading QRA Trailer
4. Attach Front & Rear Extension Tubes
5. Attach Front & Rear Reflectors
6. Attach Front & Rear Waveguides
7. Antenna (QRA) Erection

* 8. LPA Erection

9. Shelter Setup (External)
10. Shelter Configuration (Internal)
11. Klystron Adjustment
12. Antenna Alignment

C. AN/TRC-170(V)2 Teardown Tasks.

* 1. LPA lowering and Disassembly

2. Lowering Antenna One
3. Antenna One Disassembly
4. Lowering Antenna Two
5. Antenna Two Disassembly
6. Loading & Packing the Low Profile Pallet

D. AN/TRC(V)3 Teardown Tasks.

* 1. LPA Disassembly

2. Lowering QRA Antenna
3. Remove and Store Extension Tubes
4. Load QRA Trailer

Note. The setup tasks marked with "*" are not included in the setup time line criteria. The established criteria for setup of the V2 is four (4) hours and for the V3 two (2) hours. The established criteria for V2 and V3 teardown is two (2) hours. The failure of the crew to meet these times wa judged to be an Operational Mission Failure (OMF).

Questionnaire and Interview data. The following Questionnaires and Interviews were developed and administered:

A. Operator Interview - Training. Given to the operators and maintainers (N=38) during the first part of Test Phase III (Oct. 1986).

B. Operator Interview. Given to the operators (N=35) near the end of the test (2-7 Dec. 1987)

C. Data Collectors. Given to this group (N=35) during the middle of Test Phase III (Nov. 1986).

D. Test Directorate Interview. Given to 12 TD personnel having in-test, in-field experience with the AN/TRC-170. Administered at end of test (9-16 Dec. 1986).

E. Unit Interview. Given to supervisory personnel of the 526th and planning personnel of the supporting units (N=13). Administered at end of test (1-16 Dec. 1986).

F. Maintainers Interview. Given to this group (N=3) at the same time as Operator Interview.

Informal Interviews. Problems and unusual events identified during the test were investigated. The investigations included informal interviews with various test participants. Information collected was incorporated into observational data files and when appropriate submitted as a verbal report to the DAG.

Observation. Two Human Factors and one training specialist were in the field observing test situations during the majority of test operations. A daily log of these observations was maintained during this period. The observation log is an important source of data for the MANPRINT data collection.

Side Tests. Two side tests were conducted for the MANPRINT data collection. The first was the weighing of the mobilizers. This was accomplished using the motor pool truck scales and portable wheel scales in the motor pool area. The second side test was the noise measurement which was accomplished in the 526th training area by the Human Factors specialist after the main test was completed.

Personnel Test Scores. The operator personnel test records could not be obtained during the time period of the test. The operator training (Keesler Air Force Base) test results have been obtained. No performance test score correlations are included due to the lack of appropriate data.

Personnel Demographics. Demographic information was collected from all persons interviewed. The data collected included: Age; MOS; Time in MOS; Rank; Time in Military: Civilian Education; Military Education; Number of Military schools attended.

Analysis Methods

The analysis procedures for the test can be divided into three main areas.

Computer Data Bases. Data was entered into two computer data bases. The human performance data wa entered into a minicomputer data base maintained by the Data Management Office (DMO) portion of the USAOTEA field operation at Ft. Huachuca, AZ. The interview data was entered and maintained on microcomputer data bases under the control of the operational test portion of the USAOTEA field operation. The interview data was processed with dBase III+. Percentages of people using each category for each question were computed. The comment data was sorted into subgroups and output for comment summaries. The human performance data was treated by statistical routines in the mini computer system.

Statistics. The statistics used consisted of mean, standard deviation, and percentages. A Pearson r was attempted on the training test scores versus performance time and versus RAM incidents. The correlation matrix was non-significant at the .05 level. The matrix is not reported as the presentation of non-significant data would possibly be misleading.

Comment Summaries. The comment data was summarized into simple statements. The procedure used is a form of content analysis. The comments were combined to simple subject form to allow numeric counts to be made of comment frequency. The essential form of the original comments were preserved as much as possible.

Restrictions and Limitations

The performance times collected were group performance measures. No task performance time is based solely on individual performance.

Description of Test Units

Player Participants. A TOE 11-368 unit signal company (526th Signal Co, TROPO HEAVY) was trained as the AN/TRC-170(V) test unit. The unit provided functions of command and control, operations, maintenance and safety. In addition, the test unit's higher headquarters (86th Sig Bn, 11th Sig Bde) provided the necessary administrative and logistics functions to support the test unit.

(1) Unit Requirements.

PERSONNEL

POSITION	GRADE	MOS	QTY	SOURCE
Maint Rec Sup MTR AGT	E6	63B	1	USAISC
LT W Veh Mech	E5	63B	1	USAISC
PWR GEN Equip Rep	E5	52D	1	USAISC
Eq Rec & Pts Sp	E4	76C	1	USAISC
Lt W Veh Mech	E4	63B	1	USAISC
PWR GEN Equip Rep	E4	52D	2	USAISC
Rec Veh OP	E4	63B	1	USAISC
Utl Equip Rep	E4	52C	2	USAISC
LT W Veh Op	E3	63B	2	USAISC
Petro LT Veh Op	E3	76W	1	USAISC
Eq Rec & Pts Sp	E3	76C	1	USAISC
PWR GEN Equip	E3	52D	2	USAISC

(2) Platoon HQ

Plt Ldr	O2	25A	2	USAISC
TAC Sat Mw Sys Supv	E7	26Q	2	USAISC
Sngl Chan Rdo Op	E4	26Q	2	USAISC

(3) TROPO Section Medium

TAC Sat Mw Sys Supv	E6	26Q	6	USAISC
TAC Sat Mw Sys Op	E5	26Q	6	USAISC
TAC Sat Mw Sys Op	E4	26Q	6	USAISC
TAC Sat Mw Sys Op	E3	26Q	6	USAISC

(2) TROPO Section Medium

TAC Sat Mw Sys Supv	E6	26Q	2	USAISC
TAC Sat Mw Sys Op	E5	26Q	4	USAISC
TAC Sat Mw Sys Op	E4	26Q	4	USAISC
TAC Sat Mw Sys Op	E3	26Q	4	USAISC

PERSONNEL

POSITION	GRADE	MOS	QTY	SOURCE
C & E Maintenance				
C & E Maint Ch	E7	32Z	1	USAISC
Mat Contrl & Acc Sp	E4	76P	1	USAISC
TAC Comm Sys Opr/Mech	E4	31V	1	USAISC
TAC Sat Mw Sys Rep	E4	26L/29M	1	USAISC
COMSEC Rep	E4	29S	1	USAISC
(2) Other Personnel Requirements (Outside of player unit)				
Opr Crew				
AN/TRC-112	E3/E4/E5	26Q	6	FORSCOM
AN/TRC-117	E3/E4/E5	31M	6	FORSCOM
AN/TRC-145	E3/E4/E5	31M	6	FORSCOM
Terminal Device Oprs	E3	72E	6	USAISC
Clerk Typist (Term Device Ops)	GS3/4	CIV	4	LOC HIRE

MANPRINT FINDINGS

Summary of Findings

Manpower

1. The number of maintainers should be increased.
2. The crew size for each system should be increased.

Human Factors

1. The mobilizer (M720) should be replaced.
2. The anchors (antenna & LPA) need to be improved.
3. Procedures involving offloading, loading, and storage on the low profile pallet need to be improved.
4. Procedures involving offloading, loading, and storage on the QRA trailer need to be improved.
5. The truss baseplate interface requires modification.
6. The antenna pins need to be more rugged and to fit better.
7. The 10kw generator system needs to be upgraded.
8. The waveguide interface with the system needs upgrading.
9. The maintenance access to the V3 shelter does not meet standards set in MIL-STD-1472C.
10. The ruggedness of the 9.5 ft antenna needs improvement.
11. The system needs an high frequency (HF) radio as part of its current fielding.
12. The shelter should be equipped with an environmental control unit (ECU).
13. The built in test equipment (BITE) needs to be improved.

Personnel

1. Operators and maintainers have the mental ability to perform Critical Tasks required for System operation.
2. Given current crew sizes additional physical selection criteria are needed to support the system.
3. Operators and maintainers lack knowledge needed to perform Critical Tasks required for System operation.
4. Critical task performance times show that specific tasks need to be modified and/or better trained.

Safety:

1. The assembly and tear down of the 9.5 ft. antenna involves correctable safety hazards.
2. The use of the Pionjar is dangerous and training is needed in safety procedures for this equipment..
3. The loading/unloading of the low profile pallet involves correctable safety hazards.
4. The M720 mobilizer is dangerous.
5. The shelter environment has severe safety hazards.
6. Shelter access (when truck mounted) is a safety problem with present equipment.
7. Lighting for night setup/tear down operations is not adequate for safety.

Health Hazards:

1. Microwave radiation.
2. Noise.
3. Vibration.
4. Muscle-Skeletal stress/trauma.

Training:

1. The manuals and publications require changes.
2. The reading grade level of the manuals should be reduced.
3. The D6 course needs more practical exercises.
4. The operators need better training in trouble shooting the system, especially end-to-end problems.
5. The maintainers need a course developed for them.
6. There needs to be planning and support for unit level training.
7. The supervisory and planning personnel need to be trained.
8. The Pionjar needs to be included in the training system.
9. The COMSEC interface with the system needs more in-depth training.
10. The operators need better skills in site layout (including azimuth determination).

Manpower Problems

The overall manpower problem of crew size (3 versus 4 persons) was voted upon by the members of the MANPRINT scoring conference. The priority given was "A" for finding a solution for the AN/TRC-170 crew size shortage. An "A" priority is defined as follows: "The deficiency has a significant impact on human performance, leading to a high probability of mission failure, damage to the AUE, or injury to personnel" (Ref: Appendix A). There are several specific manpower problems listed that may be solved by means other than additional personnel. The group consensus was that an additional crew person is required for effective operation of the system.

Manpower Evaluation

1. Maintainers.

The number of maintainers allocated for system support is inadequate. (Ref: MANPRINT Problems #30, Appendix A) The AN/TRC-170 system when employed will be geographically dispersed at least as much as it has been during the test (test area was approximately 8700 square miles). The ability of the maintainers, while good, has not been sufficient to provide 24 hour-a-day coverage with one person. The test used three maintainers, but only one (29M) maintenance person is authorized in the unit TO&E.

Supporting Data. Questionnaire results show that 69% (24/35) of operators, 75% (9/12) of test directorate personnel, and 92% (12/13) of unit respondents indicted that the maintainer strength and organization was inadequate. (Reference Appendix B questions: 067, T57, U54)

2. Crew Size.

The manning for the AN/TRC-170(V)2 is three persons but four person lifts are required for loading/unloading of the low profile pallet (9.5 ft. antenna system). (Ref. MANPRINT Problem #01, Appendix A). The 3 man crews will be subject to potential short term injuries such as back strain, muscle strain, contusion, abrasions, and broken bones. The long term effects include stress related illness and reduction in retention of these personnel. The AN/TRC-170(V)2 may suffer Operational Mission Failure due to this problem.

The minor accident rate included wrist, ankle, and shoulder sprains along with cuts, abrasions, and a broken finger. The crews made many fatigue related mistakes and morale was low. The crew size could be increased by the addition of a maintainer (29M or 29S), the addition does not have to be a 26QD6 operator. There will be, by random selection factors, operator personnel who are above average in size and physical strength making three person crews possible. There will also be those that are

smaller requiring four person crews. The procedures for the truss assembly can be modified to reduce the weight lifted by disassembling the truss on the pallet, the problem then is the probable increase of setup/tear down Times.

The AN/TRC-170 V2 & V3 systems each include two vehicles. Army regulation and highway safety standards call for two persons (driver & assistant driver) for trips of longer than ten hours. There are only three crew members for these two vehicles assigned as prime movers. (Reference MANPRINT Problem #02, Appendix A). The unit SOP(s) locally and most likely Army-wide require a second person (assistant driver) when a vehicle is towing equipment. The assistant driver also performs as a ground guide (both vehicles in V2 & V3 are used to tow equipment). It is sound safety policy to require two persons per truck for convoy situations.

The peacetime employment of the system will require that additional personnel be supplied by the unit during movement and exercise employments. The situation in wartime will most likely be overlooked. This brings up the potential loss of the system due to driver fatigue and/or other single driver accident problems. The crew size places the unit in the position of violating safety rules or not getting the system to the field in a timely manner. The crew size for both systems should be increased to four persons. The fourth person does not necessarily have to be from the 26Q MOS.

The three person manning for each AN/TRC-170(V) does not provide enough personnel to meet tactical manning requirements. (i.e. radio operation and/or perimeter security). (MANPRINT Problem #03, Appendix A). The employment of the AN/TRC-170(V) systems is going to include situations where one or two systems are set up, isolated physically from all other military units. If there are two systems the manning calls for seven persons (three in each crew and a supervisor) and if only one unit, the manning will be three or four persons depending on the location of the supervisory NCO. Tactically the crews must man the AN/TRC-170(V) with at least one person at all times, man the high frequency (HF) radio or any other command and control radio at all times, and provide site/perimeter security 24 hours a day. There are not enough personnel assigned to the system to accomplish these requirements. The crew will suffer extreme fatigue trying to meet all these requirements in the tactical situation. The result will be potential loss of the use of the system due to operator error and/or failure of site security. The unit TO&E should be increased to provide additional personnel to satisfy these manning requirements.

The Lightning Protection Assembly (LPA) requires four persons for safe erection/disassembly. (MANPRINT Problem #05, Appendix A). The LPA erection procedures in the operators procedure section of the manual calls for four persons (crew size is three persons). The procedures ask for one person holding the base plate, one walking the mast up, and two on guywires to control the mast. Given the current equipment and less personnel than are called for, a situation is created

during which the mast may fall in an uncontrolled manner. The LPA is erected next to the AN/TRC-170 antennas and shelter. An uncontrolled fall could damage either portion of the system. The personnel are also potentially endangered by the possible uncontrolled falling of the LPA mast. Human Factors personnel have observed numerous problems during erection including more than 10 uncontrolled falls of these masts. In one case an operator had the mast fall onto his shoulder causing a painful injury. The current base plate should be replaced with a hinged baseplate. The training system should demonstrate correct erection/disassembly procedures to all 26QD6 personnel during specialty training. The crew manning level should be increased to assure adequate personnel for safety.

Supporting Data. No respondents considered three person crews adequate for all the critical tasks involved in setup/teardown, or operation of the AN/TRC-170 system. Specific tasks for which the inadequacy was identified are as follows:

TASK	% "INADEQUATE" RESPONSE			
	OP	TD	DC	UNIT
Erect LPA	83% (29/35)	92% (11/12)	86% (30/35)	77% (10/13)
Disassemble LPA	66% (23/35)	83% (10/12)	80% (28/35)	69% (9/13)
Unload low profile pallet	43% (15/35)	58% (7/12)	43% (15/35)	62% (8/13)
Erect 9.5' antenna (V2)	57% (20/35)	75% (9/12)	51% (18/35)	77% (10/13)
Disassemble 9.5' antenna	49% (17/35)	67% (8/12)	46% (16/35)	54% (7/13)
Manhandle V2 shelter/ Mobilizers	94% (33/35)	92% (11/12)	97% (34/35)	100% (13/13)
Maneuver QRA	29% (10/35)	25% (3/12)	40% (14/35)	5% (1/13)

(OP = Operator; TD = Test Directorate; DC = Data Collectors; Unit = Unit Personnel)

Comments from interviews:

Two Section Chiefs commented that the size of the crew is important; three small persons could not accomplish the V2 tasks. One SC stated that LPA needed redesign to be handled by three people.

V2 Operators

Three persons on the LPA is dangerous	= 3
Crew can not unload without physical risk	= 3
It depends on how hard the ground is on site	= 3
Antenna assembly and anchors take too long	= 3

V3 operators

Three persons on the LPA is dangerous	= 4
It depends on how hard the ground is on site	= 5
Antenna assembly and anchors take too long	= 2

Data Collectors

LPA can be done, but unsafe with less than four people	= 11
Fatigue a problem (also shift schedule)	= 4
Need a truck, shelter should not be moved by hand	= 6

Test Directorate

LPA needs at least four people with current design	= 3
Fatigue a real problem with small crew (need 4)	= 3

General Comment: Anchors cannot be retrieved, consequently cannot be used in some locations (e.g., private property, Federal Republic of Germany, etc.).

Human Factors

Human Factors Engineering Evaluation.

1. Mobilizer (M720):

a. Mobilizer Positioning: The manual positioning of the mobilizer (M720), used to transport the AN/TRC-170(V)2 shelter, is unsafe. (Ref: MANPRINT Problem #04, Appendix A). The mobilizer (M720) used for the AN/TRC-170(V)2 cannot be backed up while connected to the prime mover (2.5 ton truck) by the present hitch system. The length of the hitch and its angle while connected make this an unsafe operation. The mobilizer must be driven into position in only a forward manner. The mobilizer could be moved manually if sufficient personnel are available (at least 8 strong persons), but this procedure is not recommended and has a number of unsafe aspects.

Supporting Data:

TASK	% "INADEQUATE" RESPONSE			
	OP	TD	DC	UNIT
Manhandle V2 shelter/ mobilizer	94% (33/35)	92% (11/12)	97% (34/35)	100% (13/13)

Small personnel size - strength factors further aggravate the crew number problems.
(Reference Appendix questions: O62, O73, T69, D62, U22)

b. Mobilizer Field Utility. The mobilizer (M720) used for transporting the AN/TRC-170(V2) system is not adequate for the task and a different system for movement is needed. (Ref: MANPRINT Problem #24, Appendix A).

The weight distribution and balance of the V2 shelter is a problem. (Ref: MANPRINT Problem #35, Appendix A). The electronics and radio equipment of the AN/TRC-170(V)2 system within the shelter are all located upon the roadside. The Air Force has determined that the shelter is not stable on over a twenty degree side tilt when loaded upon the mobilizer.
The AN/TRC-170(V2) system must be able to be moved into off road area for site set up. The present Mobilizer (M720), with the wheels as fielded, has less than a one foot road clearance, which is not adequate for the mission. The shelter will be used to transport other equipment in a normal tactical environment and will be loaded at or over capacity during off road travel. The use of any vehicle at maximum load capacity in rough terrain is not advisable. It is expected that the rate of break down of the mobilizers will be unacceptable. The potential for accidents resulting in system loss are increased.
The system should be mounted upon a truck for usual non tactical employments of the system. The use of the mobilizer should be restricted to situations requiring air mobility. The system should not continue to use the (M720) mobilizer unless heavy duty wheels are used and cargo restrictions are carefully followed by the system user.

Supporting Data: Questionnaire responses were as follows: 43% (15/35) of operators, 58% (7/12) of test directorate respondents, 74% (26/35) of the data collectors, and 69% (9/13) of the unit respondents reported problems with the V2 mobilizer. The problem was the disintegration of tires and wheels. Often lug nuts would break allowing wheels to fall off. Usually the problem was with front and rear roadside wheels. There are six mobilizers (M720) being used in the test; four of them were deadlined due to weight related problems (sheared off lug posts). Five of the six had some related damage. Each tire used is restricted to an 1800 pound load limit. The weight on the roadside wheels is (2075 front and 2255 rear) over the safety limits with no unauthorized cargo. The gross weight of the authorized load was 7470 pounds, an overload of 220 pounds. The wheels were weighted with tactical cargo (roadside 2290 front and 2430 rear) and the overall weight (8620 lbs) exceeded safety standards (Ref: Appendix J). It was later contended that no extra gear was authorized to be carried in the shelter. Almost without exception, those responding to interview questions about the mobilizer were in favor of truck mounting for the van or the design/acquisition of a much heavier duty mobilizer. The M720 is good for one thing, to get the shelter on and off of a C-130 or C-141.
(Reference Appendix B questions: O23, O83, O84, T83, T84, D23, D111, D112, D168, U38, U52, O168, U50, T169)

2. Anchors (Antenna & LPA).

The anchors (duckbills) provided for use with the 9 & 1/2 ft. antenna system are only one size and at least two sizes are required (includes LPA anchors) to meet differences in ground hardness. (Ref: MANPRINT Problems #07 & #08, Appendix A). The diameter of the duckbill portion of the supplied anchor is larger than the pilot hole drilled by the Pionjar with the supplied drill bit. The anchor is designed to hold in soft ground and can be driven in such ground. The difficulty comes in trying to use the anchor in hard or rocky ground. The supplied anchor is not shaped to aid in the driving process (Pionjar drive rod often punches through them). The present anchor design is also excessively expensive. An extensive price comparison was not done, but other anchors were demonstrated that cost less than half the present system and had equal strength characteristics.

The drive rods of the Pionjar are being driven through anchors and getting stuck in the anchors holes causing a great amount of time and effort to be expended to retrieve them. (Ref: MANPRINT Problem #09, Appendix A).

The antenna anchors, when abandoned are an Intelligence indicator. One of the data collectors observed that anchors left in the ground upon moving a V2 site tell the enemy where the site was and where its antennas were pointing. The distant end might still be there. The indicator thus provides order of battle and target acquisition information to the threat collection agency. (Who and what type of element occupied the site; probable direction and distance/range to the distant end station.) (Reference Appendix B question: D67).

Supporting Data: Questionnaire responses were as follows: 74% (26/35) of the operators, 37% (13/35) of the data collectors, and 85% (11/13) of unit respondents considered the duckbill unacceptable. The primary reasons cited were:

a. It is practically impossible to install them in rock or very hard soils.
b. They cannot be retrieved, consequently cannot be used in some locations (e.g., private property, Federal Republic of Germany, etc.).
c. Pionjar sometimes drives a rod through the anchor. Rod cannot be removed.

(Reference Appendix B questions: O74, D67, U27)

3. Low Profile Pallet.

The location of the accessory kit (includes the pocket transit) on the low profile pallet is in the middle on the bottom of the pallet. The pocket transit is the first item needed for site layout. The crew must remove the canvas cover from the pallet and push antenna parts out of the way to retrieve the kit. (Ref: MANPRINT Problem #10, Appendix A).

The loading/unloading procedures for the low profile pallet require the crew members to assume unsafe positions. (Ref: MANPRINT Problem #23, Appendix A). This is particularly true when removing the canvas cover due to the requirement that the crew members walk along the truck side rail (3 inches wide and 5 feet off the ground) and when retrieving the accessory kit also from the side rail or by climbing through the loaded pallet.

Supporting Data: This problem was first observed by MANPRINT staff personnel during field operations. 51% (18/35) of operators and 54% (19/35) of data collectors stated they would move some items. These were:

a. Accessory kit off pallet (15 persons)
b. Stow bags in shelter (4 persons)
c. ROCU in shelter (5 persons)
d. Pionjar out of shelter (1 person)
e. Rotate V3 Pionjar box 90 degree (1 person)

(Reference Appendix B questions: O81, D108)

4. QRA Trailer.

The location of the accessory kit (includes pocket transmit) on the QRA trailer is difficult to access (the pocket transmit is the first item needed for site layout). (Ref: MANPRINT Problem #11, Appendix A).

Supporting Data: This problem was observed by MANPRINT staff personnel during field operations.

5. V2 Antenna.

The rear (truss) clamp which locks down the bearing ball on the end of the truss assembly binds. The problem occurs when the antenna is set to the 15 ft. height versus the 10 ft. height. The clamp cannot be closed without lifting the loaded baseplate, a job that is both heavy and dangerous. (Ref: MANPRINT Problem #16, Appendix A). There should be a relief cut milled into the cap plate to prevent this.

The rear (truss) baseplate cannot use the anchor in the usual manner during the erection/teardown process. (Ref: MANPRINT Problem #21, Appendix A). There needs to be a way to keep the anchor cable out of the way during the procedures. The anchor cable is put through a hole in the side of the baseplate to protect the cable and to keep the cable out of the way; however some of the rear baseplates do not have the hole.
Supporting Data: The truss clamp problem was commented upon by one operator and observed by MANPRINT staff during field operations. (Reference Appendix B questions: 099, D127)
The truss baseplate problem was observed by MANPRINT staff personnel during field observations. Confirmed by discussion with operators, maintainers, Air Force and Raytheon representatives.

6. Antenna Pins.

The pins used on the AN/TRC-170(V2 & V3) antennas are difficult to use and slow down the set up/teardown process. (Ref: MANPRINT Problem #25, Appendix A). The pins are used to hold the antennas together and to secure antenna parts to the low profile pallet. The pins fit very tightly and are very difficult to install and remove. The pins have been damaged by attempts to install/remove them using improper methods and means.

Supporting Data: Questionnaire responses are as follows: 44% (16/35) of operators, 75% (9/12) of test directorate personnel, 54% (19/35) of data collectors, and 62% (8/13) of the unit supervisory personnel did not believe AN/TRC-170 components to be adequately rugged to withstand continued field use. Thirteen individuals complained of pins fitting too tightly and/or coming apart in use. MANPRINT staff personnel observed these problems at every monitored setup/teardown. Pin handles came off very frequently. Spare pins were scarce or unavailable.
(Reference Appendix B questions: 083, T83, D111, V38)

7. 10kw Generators.

The 10kw generators supply power for the V3 version of the AN/TRC-170. There are two generators mounted on a single trailer with the mission of supplying continuous power for the radio system. The power cannot be switched from one generator to the other without a power interruption because of the lack of a proper power switching system for the generators. (Ref: MANPRINT Problem #26, Appendix A).

The 10kw generators used to support the AN/TRC-170(V3) system do not have the appropriate built-in capability to adjust for power load variations. (Ref: MANPRINT Problem #27, Appendix A).

Supporting Data: The power interruption problem was observed during field operations and reported on the daily narrative general comment forms submitted to the data management office; also as a cause of RAM incidents reported to DMO and maintainers during the test. The variation in power/load requires a manual readjustment to prevent possible system damage. Operator has to run out to the generator trailer to do the adjustment.
(Reference Appendix B question: T82)

8. Waveguides.

The waveguide attachment to the antenna and the shelter needs redesign. (Ref: MANPRINT Problem #31, Appendix A). The alignment pins are not secure. The o-ring used as a moisture seal is not fixed and falls out very easily. The latch is manually difficult to secure or release. The latch problem is made worse by protective gloves and, it is assumed, by arctic gloves.

Waveguides for the V2 system are being damaged during setup/teardown when they are not stored on the low profile pallet. (Ref: MANPRINT Problem #43, Appendix A).

Supporting Data. Questionnaire responses were as follows: 43% (15/35) of the operators commented that the waveguide clamps needed redesign; 17% (2/12) of the test directorate personnel made this comment; 40% (14/35) of data collectors said the same thing. The waveguides damage problem was detected by MANPRINT staff personnel and RAM/maintenance personnel during the test. Over 33% of the waveguides were judged unusable for the transmission side on the V2 at one point in the test. (Reference Appendix B questions: 099, T118, 0119)

9. Maintenance Access.

The access for maintenance in the V3 does not meet military standards as given in MIL-STD-1472C paragraph 5.9.3 - 5.9.4. (Ref: MANPRINT Problem #34, Appendix A). The space within the shelter is restricted. The hand and arm room behind the panels is so limited that average size persons have difficulty accessing fasteners for component removal. The torque to remove fasteners is so high that mechanical aids are needed. Components that weigh enough to require two person lifts are located so access is limited to one person.

Supporting Data: Questionnaire responses were as follows: 64% (7/11) of the V3 operators said the van is too small. Klystron removal/replacement in the V3 was rated as particularly difficult because of the small space. 49% (17/35) of the data collectors commented that the V3 shelter did not provide adequate space to remove/replace klystron or heavier components, such as power supplies, etc. This evaluation wa repeated by 67% (8/12) of the test directorate respondents. (reference Appendix B questions: T163, T165, 0165, 0150, U51)

10. Tactical use of the 9 & 1/2 ft. V2 Antenna.

The 9.5 ft. antenna for the AN/TRC-170(V2) is not adequate for tactical deployment; it is a semifixed site antenna. (Ref: MANPRINT Problem #37, Appendix A).

The majority of the MANPRINT scoring conference were of the opinion that there was not sufficient evidence to support problem number 37. The economic costs of replacing the V2 antenna system would be very large and was an important consideration in the deferment of this issue.

Supporting Data: All V2 section chiefs interviewed stated that the V2 9.5' antennas were not strong enough to withstand the repeated setup/teardown required by the Army tactical environment. One of these also stated "hooks, clips, and LPA antenna baseplates were easily broken." 17% (2/35) of the

operators complained about the frequency with which antenna pins were broken. 58% (7/12) of the test directorate found durability problems with the V2 antenna. These were: pins break too easily (5 persons); antenna wrenches and hoist (jack) cables are deficient (1 person); antenna anchor system unacceptable (2 persons); waveguide connection arrangement isn't reliable enough (1 person). Data collector opinions support this position. 20% (7/35) stating, "pins aren't sufficiently rugged"; 14% (5/35) also stated that the "V2 antennas aren't durable enough for frequent assembly/disassembly." Three unit respondents (23%) made the same comment. Four operators (12%) rated the 9.5' antenna as more difficult to set up than the AN/TRC-132A which is one of the systems the AN/TRC-170(V) is designed to replace. 42% (5/12) of the test directorate respondents agreed that the anchors and antenna made the V2 harder to set up than the outgoing systems (AN/TRC-132 & AN/TRC-132A).
(Reference Appendix B questions: O83, T83, O102, D111, V38)

11. HF Radio.

The AN/TRC-170(V) system has a recognized need for a HF radio. The proposed HF radio is not available at this time for fielding with the system. (Ref: MANPRINT Problem #38, Appendix A). The HF radio is, in the opinion of the MANPRINT staff, critical in end-to-end establishment of communication and maintenance management of the deployed AN/TRC-170(V) units. A substitute HF radio is imperative. Lack of HF radio associated with each shelter will result in failure to establish the links in a timely manner and thus lead to Operational Mission Failures.

Supporting Data: This observation is based upon comments made by operators and section chiefs during the test. Additionally, MANPRINT staff members noted that almost invariably during setup at new sites and also when configuration changes were made, HF commo was needed to coordinate actions at both ends of the link.

12. Shelter ECU.

The AN/TRC-170 shelters should each be equipped with an Environmental Control Unit (ECU) that both heats and cools the shelter. (Ref: MANPRINT Problem #41, Appendix A).
The majority of the MANPRINT scoring conference voted to eliminate problem 41 due to the fact that no environmental testing was conducted to support or eliminate this issue during this test. There has been an administrative decision made that ECUs are not required for the AN/TRC-170(V) system.

Supporting Data: One unit respondent made the above recommendation that ECUs be required. The overall questionnaire responses were that 40% (14/35) of the data collectors agreed, as did 33% (4/12) of the test directorate respondents . 40% (14/35) of the operators wanted an ECU in the vans. 34% (12/35) of the operators and 20% (7/35) of the data collectors reported that the heaters don't work at all. The only ones interviewed who did not report a heater problem stated that they had not

used the heaters. There were no instances of heaters being reported as actually producing any heat.
(Reference Appendix B questions: D129, T111, O111, V60)

13. BITE.

BITE (fault lights) gave false information, did not detect actual problems and operators can't distinguish between local and distant end problems.

Supporting Data: Interview responses: 31% (11/35) of the operators indicated BITE problems. Comments from the Section Chiefs (SC) included that there was no indicator for orderwire lockups and that the Fault lights indicated the wrong problem on two occations. The V2 operators reported that the Fault lights did not detect dented waveguide and also reported that loose connectors on the patch panel plugs and patch wire loose were not detected and problems at distant end but fault light on in our van. The V3 operators reported problems at distant end but fault light on in our van. V3 operators reported problems in the van but no fault light. One V3 operator commented that in his van a power converter was off 50kh with no fault light and the HPA fault lights did not function. One of three maintainers indicated BITE problems. Maintainers commented as follows: In the VOCU a fault light on CCA, but found VINCINT buffer, electronic bridge were defective. Light not on in them. BITE did not give adequate diagnosis. 42% (5/12) of the test directorate respondents reported problems which weren't identified by BITE; or more significantly, could not be isolated as to which end of the link had a fault. This caused a lot of lost time checking out the wrong end of the link. With the current maintenance doctrine, this factor could result in sending the authorized (1 ea) maintainer to a location ±150 miles away from where the faulty equipment is emplaced.
(Reference Appendix B questions: M37, O37, T37)

Personnel Evaluation:

1. Operator ability to perform the tasks required.

The overall conclusion is that the majority of the operators can perform most of the tasks in a satisfactory manner. There are exceptions that are related to individual abilities, but in general the problems relate to training and experience. Not surprisingly, the operators considered themselves SQT qualified to perform the critical tasks involved in setup and operation of the system, as well as those maintenance tasks they were allowed to perform. The tasks listed by observers as being problems are all noted as training deficiencies.

Supporting Data: The unit supervisory personnel interviewed indicated that the operators were proficient in critical task performance, except as follows: "Do operators perform well enough to pass an SQT?"

		Percent "No"	N
a.	Fault diagnosis without BITE	69%	(9/13)
b.	Fault isolation with flowcharts	23%	(3/13)
c.	Removing/replacing components	30%	(4/13)
d.	Antenna adjustment/alignment	23%	(3/13)

Overall, the test directorate respondents concurred with the unit supervisory sample, but there were some differences:

	Percent "No"	N
a. Configuring system with assignment sheet	25%	(3/12)
b. Recognizing faults during configuration	33%	(4/12)
c. Fault diagnosis using BITE	25%	(3/12)
d. Performing PMCS	33%	(4/12)
e. Removing/replacing components	50%	(6/12)
f. Site layout	25%	(3/12)
g. Antenna adjustment/alignment	25%	(3/12)
h. Pionjar operation/maintenance	25%	(3/12)
i. Pocket transit operation/interpretation	33%	(4/12)

Those operator tasks that the data collectors identified as being performed less than satisfactorily were those associated with fault identification:

	Percent "No"	N
a. Fault diagnosis using BITE:	23%	(8/35)
b. Fault isolation using flowcharts:	49%	(17/35)
c. Fault diagnosis without BITE:	51%	(18/35)
d. Removing/replacing shelter components:	31%	(11/35)

Most of those interviewed (92% (11/12) of the Test Directorate personnel, 69% (9/13) of unit personnel and 51% (19/35) of data collectors) indicated a belief that additional individuals and/or collective training would be beneficial. Except for fault diagnosis without using BITE, unit respondents agreed that the operators were SQT qualified on the system. 40% (14/35) of the data collectors thought operators did not know how to set up a tactical tropo radio site.

2. Has the Correct MOS been Assigned to this System.

The general consensus is that the correct MOSs have been selected to operate and maintain the AN/TRC-170.

3. Can the Maintainers perform required tasks.

Of the three maintainers used in the test, one was given operator training and the NETT training which covered some maintenance remove and replace tasks, one received operator training only, and the third had no AN/TRC-170(V) specific training at all. Given these restrictions, the maintainers have the capability, but not the knowledge. The consensus of supervisory personnel is that the maintainers can accomplish most tasks. The exceptions can be accomplished with additional training and experience.

Supportive Data: When asked to rate maintainer proficiency in removing/replacing system components, ("perform well enough to pass an SQT") data collectors responded as shown:

INTERVIEW ITEM #/COMPONENT	% "NO"
75. RF Amplifier	69% (24/35)
76. Control logic assembly	51% (18/35)
77. Control logic assembly cards	34% (12/35)
78. High Voltage power supply	40% (14/35)
79. Fast Interrupt (FAINT)	57% (20/35)
80. Inverters	51% (18/35)
81. RF Protect/Metering	49% (17/35)
82. Klystron	46% (16/35)
83. Amplifier up-converter	46% (16/35)
84. Downconverter	46% (16/35)
85. Dual RF synthesizer	40% (14/35)
86. Tropo modem modulator	49% (17/35)
87. Tropo modem demodulator	51% (18/35)
88. TED 1 and 2	40% (14/35)
89. COMSEC gear in general	43% (15/35)
90. Low voltage power supply	43% (15/35)
91. Loopgroup multiplex (LGM-1)	49% (17/35)
92. Group modem (GM)	46% (16/35)
93. Trunk group multiplexer	51% (18/35)
94. LGM-2/LSCDM	51% (18/35)
95. AC to AC converter	40% (14/35)
96. Shelter internal cables	86% (30/35)
97. Alarm monitor	51% (18/35)
98. Orderwire control unit	46% (16/35)
99. IF test panel	46% (16/35)
100. Noise source	49% (17/35)
101. Flushing fan	51% (18/35)
102. ROCU	46% (16/35)
103. LED MATRIX circuit card assy	51% (18/35)

Maintainers were asked "Have you had any difficulty understanding the AN/TRC-170 maintenance problems?". One maintainer said "yes" and pointed out end-to-end trouble shooting as the main problem.

4. Personnel Demographics.

a. OPERATORS: N = 35 MOS: 26QD6

GRADE:	E5	E4	E3
	4	6	25

AVERAGE AGE 21.0

AVERAGE TIME IN Military = 2.3 years MOS = 1.4 years

AVERAGE CIVILIAN EDUCATION = 12.2 YEARS

AVERAGE MILITARY EDUCATION = 7.0 MONTHS

MILITARY SCHOOLS ATTENDED (AVERAGE) = 2

RESPONDENTS PER SYSTEM
V2 = 19 V3 = 11 SECTION CHIEFS = 5

b. MAINTAINERS: N = 3 MOS: 29M

GRADE:	E4
	3

AVERAGE AGE 27.6

AVERAGE TIME IN Military = 3.8 YEARS; MOS = 2.6 YEARS

AVERAGE CIVILIAN EDUCATION = 12.6 YEARS

AVERAGE MILITARY EDUCATION = 13.6 MONTHS

MILITARY SCHOOLS ATTENDED (AVERAGE) = 3

5. Physical Requirements.

If the crew size stays at three persons the physical size requirements for the D6 skill identifier will need to be modified. The operators will need to be selected for height and strength requirements needed to accomplish tasks with reduced manning.

Supporting Data: Interview responses were as follows: 69% (9/13) of the unit personnel believed that there should be a physical size and strength prerequisite added to the criteria for award of the 26QD6 MOS because of the lifting and assembly requirements for the 9.5' V2 antennas. 42% (5/12) of the test directorate respondents agreed ("need bigger/stronger personnel, unless crew size is increased"). 20% (7/35) of the data collectors also thought there was a need for size and strength selection criteria.

6. Operator/Maintainer Knowledge.

Were the MOSs tested (26QD6 & 29M) knowledgeable enough to perform the required tasks? The training system needs to be improved. The operators and maintainers both lacked critical knowledge. The operators lacked knowledge about system trouble

shooting, site selection, site layout, radiation hazards, general safety procedures, radio communication protocols, vehicle positioning (towing & backing), and came to the field environment needing extensive additional training. Only one maintainer received any specialized training for maintenance of the AN/TRC-170(V) system. The maintenance training received was limited to remove and replace tasks with very limited trouble shooting instruction. Given these restrictions, the operators and maintainers have the capability, but not the knowledge.

Supporting Data: The consensus of supervisory personnel is that the operators and maintainers can accomplish most tasks. The exceptions can be accomplished with additional training and experience.

7. Critical Task Performance.

A. V2 System.

A performance OMF for the V2 system is defined as set up time in excess of 240 minutes for a combination of all tasks except LPA erection and anchors. Observations were made of 44 setups of which 43% (19/44) were performance OMFs. The tasks which according to data collected are the most time consuming are listed out below for the V2 system. These tasks drive the set up times and the possibility of an OMF for the V2 system. These tasks are also the ones from which the most benefit can be derived by making improvements.

a. Azimuth Stake Out: This task was observed 24 times during the test with an average time of 10.6 minutes (Table 1) for completion. The maximum time was 62 minutes or in other words 26% of the maximum allowed time for setup. This task must be accomplished before any other setup task can be started. This is the task that requires the M2 compass from the center of the low profile pallet. The data (Table 3) shows that the more people involved in the task the longer it took to finish. It is likely that the more difficult the azimuth determination the more crew members that got involved.

b. Antenna Base and LPA Stake Out: This task was observed 20 times during the test with an average time of 20.1 minutes (Table 1) for completion. The maximum time was 46 minutes or 19% of the 240 minute setup criteria. This task follows azimuth stake out and preceeds the other setup tasks. This task must be completed before the time consuming task of drilling and setting anchors can start. The data (Table 3) on number of persons involved in the task indicates that more people do not speedup this task.

c. Offloading the Low Profile Pallet: This task was observed 41 times during the test with an average time of 59.9 minutes (Table 1) for completion. It is important that the average time to complete this task is 25% of the total time allowed for setup of the system. The maximum time recorded was 230 minutes or close to the time allowed for all setup tasks not just this one. This task is done in parallel with the antenna setup tasks, so the length of time is not as critical as the first two tasks reviewed. The maximum time is totally out of line and would be a performance OMF. This task is one that can be speeded up by more crew members getting involved (Table 3).

d. Shelter External Set Up: This task was observed 43 times during the test with an average time of 35.2 minutes (Table 1) for completion. The maximum time was 270 minutes or 30 minutes over the 240 minute setup criteria. This task can run parallel with the antenna setup tasks. The data (Table 3) on number of persons involved in the task is inconclusive, but most likely more people can do the task faster. In 86% (37/43) of the observations more than one person was involved in this task.

e. Shelter Internal Set Up: This task was observed 43 times during the test with an average time of 24.7 minutes (Table 1) for completion. The maximum time was 142 minutes or 59% of the 240 minute setup criteria. This task can run parallel with the antenna setup tasks, but requires power hookup to be completed (Shelter External Setup, subtask). The data (Table 3) on number of persons involved show that this is primarily a one person task (58% of the observations) and if more people are involved the task takes more time.

f. Klystron Adjustment: This task was observed 42 times during the test with an average time of 10.9 minutes (Table 1) for completion. The maximum time was 94 minutes or 39% of the 240 minute setup criteria. This task is a subtask of the shelter internal setup. The data (Table 3) on number of persons involved show that this is primarily a one person task (81% of the observations) and if more people are involved the task takes more time.

g. Antenna Alignment: This task was observed 39 times during the test with an average time of 45.9 minutes (Table 1) for completion. The maximum time was 720 minutes or three times longer than the 240 minute setup criteria. The maximun time given occurred in a situation where the link was never satisfactorily established. This occurrance was compounded by circumstances (HF radio was unavailable) and location (the path profile was marginal) so that excessive time was spent trying to establish communications. This task can not be accomplished until all other setup tasks (except LPA) are completed. The mean time accounts for 19% of the total allowed time line. This task time is not improved by the number of people involved in task performance.

The tasks which consume the most time overall and cause the time line to be as long as it is for the V2 system should include the times for anchors and LPA. There is an overlap of tasks that are critical to the setup time. The anchors are excluded from the setup time criteria due to the indeterminance of ground hardness from one site to another. The LPA is excluded due to the fact that the system can perform its mission without this safety system. The fact is these two tasks are among the most time consuming and fatiguing for the operators.

h. Anchors (drilling and setting): This task was observed 18 times during the test with an average time of 113.0 minutes (Table 1) for completion. The maximum time during the regular test was 336 minutes or 116 minutes over the 240 minute setup criteria. During pilot test this task took 17 hours in one case of a rocky site. This task preceeds the antenna setup tasks. The task includes using the Pionjar to drill and set all the required anchors for the site. The number of anchors for the antenna ranges from six to twelve depending on soil conditions. The LPA uses six anchors and if needed there are four anchors used for high wind protection for the shelter. The total number of anchors can be twenty-two. During the test, most setups used twelve anchors. The data (Table 3) on number of persons involved in the task show that in 61% (11/18) of the observations of this task three or more persons were involved in task performance. The more crew members involved and the longer the task takes the greater the effect on the crews ability to perform the tasking that follows this activity.

i. LPA erection: This task was observed 42 times during the test with an average time of 50.9 minutes (Table 1) for completion. The maximum time during the regular test was 1753 minutes, the circumstances surrounding this setup are not available, but it is assumed that the time included some other activity such as sleeping and is not included in the overall average. This task can run parallel to the antenna setup tasks. The data (Table 3) on number of persons involved in the task show that in 98% (41/42) of the observations of this task three or more persons were involved in task performance. The more crew members involved and the longer the task takes the greater the effect on the crews ability to perform the tasking that follows.

Analysis of the performance time data has identified the critical tasks listed as the tasks on which procedures, training, and improvements should be concentrated. Data is reported on all the tasks on which data was collected in the tables on the next several pages.

Table 1.
Task Performance Time for Set Up
V2 crews Combined (time in minutes)

Task	Number of Obs	Mean	Std. Dev.	Maximum Value	Minimum Value
Azimuth Stake out	24	10.6	12.4	62	1
Antenna Base & LPA Stake out	20	20.1	15.4	46	2
Transit Frame Removal	43	3.3	4.0	26	1
Truss Removal	41	3.4	2.2	10	1
Antenna Anchors	18	113.0	99.8	336	10
Offload Pallet	41	59.9	68.0	230	10
Base Plate Install					
Antenna #1	43	9.4	12.5	67	1
Antenna #2	43	9.4	8.1	35	2
Secure Antenna Legs					
Antenna #1	44	8.3	11.1	60	1
Antenna #2	44	8.3	7.5	39	1
Install AZ-EL					
Antenna #1	44	4.4	5.4	32	1
Antenna #2	44	4.5	3.4	17	1
Install Reflector Hub					
Antenna #1	44	4.4	4.4	30	1
Antenna #2	44	3.8	1.7	7	1
Install Upper Pedals					
Antenna #1	44	5.3	5.3	29	1
Antenna #2	44	4.9	4.7	24	1
Install Roll Yoke Struts					
Antenna #1	44	4.5	2.7	15	1
Antenna #2	44	11.3	7.1	34	4
Attach Waveguides					
Antenna #1	44	6.0	4.9	33	1
Antenna #2	44	5.7	2.8	12	1
Antenna #1 Erection					
Antenna #1	44	17.7	25.4	170	3
Antenna #2	44	11.3	7.1	34	4
LPA Erection	42	50.9	262.6	262	13
Shelter External	43	35.2	61.7	270	2
Shelter Internal	43	24.7	31.4	142	2
Klystron Adjustment	42	10.9	16.3	94	1
Antenna Alignment	39	45.9	121.2	720	1

Table 2.
Task Performance Time V2 Tear Down
by Number of Persons Performing the Task
(time in minutes)

Task	Number of People	Number of Obs.	Mean	Maximum	Minimum
LPA Disassembly	3	19	14.8	30	7
	4	25	14.1	33	8
Lowering Antenna 1	2	9	6.4	13	2
	3	27	15.2	35	4
	4	8	11.6	24	2
Antenna 1 Disassembly	1	1	18.0	18	18
	2	2	16.0	17	15
	3	33	23.9	67	8
	4	8	24.2	39	15
Lowering Antenna 2	2	7	11.3	23	4
	3	30	10.0	20	3
	4	7	8.4	12	4
Antenna 2 Disassembly	2	3	22.7	40	14
	3	32	21.5	36	8
	4	9	21.3	33	9
Packing Pallet	2	2	95.5	107	84
	3	31	61.8	135	15
	4	11	54.0	90	39

An OMF for V2 teardown is defined as total task times of over 120 minutes. Observations were made on 44 teardowns and on 41% (18/44) of the observances performance OMFs were recorded due to overall task time exceeding criteria.

The tear down task that is most time consuming is the packing of the pallet. This task was observed 44 times during the test with an average time of 61.4 minutes or 51% of the criteria time for teardown. It is also clear from the break down above that crew size is important to the accomplishment of this task in a timely manner. The antenna teardown tasks are next in line for time consuming. In at least one case the time involved was 56% (67/120) of the total allowed time, for just one antenna disassembly. These three tasks should be added to the setup tasks already identified as canidates for improvement.

It should also be pointed out that tables 2 & 3 break down the task performances by the number of individuals participating in the task. It has been noted that the time involved often is longer when more people are involved in the task performance. The reasons for this apparent paradox is that often when problems occurred other crew members came to help and the data

collectors recorded more people on the task. This data collection procedure helped to create situations where apparently more people took more time to do the task. It is also likely that in some cases too many people trying to help slowed the task down. Since we do not know for sure which of these problems may have occurred in any given situation the time data by person should be interpreted carefully.

Table 3.
Task Performance Time for V2 Set Up
by Number of Persons Performing the Task
(time in minutes)

Task	Number of People	Number of Obs.	Mean	Maximum	Minimum
Azimuth Stake out	1	3	2.3	5	1
	2	5	8.2	15	2
	3	15	12.5	62	2
Antenna Base & LPA Stake out	1	1	2	2	2
	2	7	21.0	46	4
	3	11	19.5	45	3
Transit Frame Removal	1	3	3	3	3
	2	13	4.8	26	1
	3	22	2.8	8	1
	4	6	2.0	4	1
Truss Removal	2	11	5.1	10	1
	3	22	3.0	8	1
	4	7	2.1	5	1
Antenna Anchors	1	2	14.5	24	5
	2	5	97.6	258	17
	3	10	133.4	336	10
	4	1	57	57	57
Offload Pallet	2	6	33.7	215	15
	3	27	59.4	197	10
	4	5	16.8	25	11
Base Plate Install Antenna #1	1	7	12.6	55	3
	2	15	5.3	10	1
	3	15	14.4	67	4
	4	4	3.5	7	2
Antenna #2	1	12	12.4	35	2
	2	16	6.9	13	3
	3	14	9.7	32	4
	4	2	2.0	2	2

Table 3. (continued)
Task Performance Time for V2 Set Up
by Number of Persons Performing the Task
(time in minutes)

Task	Number of People	Number of Obs.	Mean	Maximum	Minimum
Secure Antenna Legs					
Antenna #1	1	1	5	5	5
	2	13	10.7	60	1
	3	23	5.2	32	1
	4	3	3.3	4	3
Antenna #2	1	1	8	8	8
	2	18	7.3	16	2
	3	21	9.3	39	1
	4	3	5.3	10	2
Install AZ-EL					
Antenna #1	2	15	3.9	16	1
	3	23	5.2	32	1
	4	4	2.3	4	1
Antenna #2	2	21	3.8	10	1
	3	18	4.5	17	1
	4	4	2.5	6	1
Install Reflector Hub					
Antenna #1	2	11	4.0	9	1
	3	28	4.8	30	1
	4	3	3.0	4	2
Antenna #2	2	11	2.8	6	1
	3	28	3.9	7	2
	4	3	2.3	3	1
Install Upper Pedals					
Antenna #1	2	17	3.3	6	2
	3	24	6.6	29	1
	4	2	5.5	8	3
Antenna #2	2	14	4.9	24	1
	3	28	4.4	13	1
	4	2	12.5	22	3
Install Roll Yoke Struts					
Antenna #1	1	1	7.0	7	7
	2	24	4.2	11	1
	3	16	4.8	15	1
	4	2	4.0	5	3
Antenna #2	1	2	4.0	5	3
	2	24	6.5	34	1
	3	17	5.0	11	1
	4	1	1.0	1	1

Table 3. (continued)
Task Performance Time for V2 Set Up
by Number of Persons Performing the Task
(time in minutes)

Task	Number of People	Number of Obs.	Mean	Maximum	Minimum
Attach Waveguides					
Antenna #1	1	10	4.4	8	2
	2	19	6.3	33	1
	3	13	6.7	15	2
	4	1	7.0	7	7
Antenna #2	1	11	5.0	8	2
	2	18	5.4	11	1
	3	14	6.9	12	2
Antenna #1 Erection					
Antenna #1	1	4	7.0	11	5
	2	9	31.5	176	3
	3	28	14.7	54	3
	4	1	21.0	21	21
Antenna #2	1	3	10.3	16	5
	2	16	11.1	32	4
	3	24	10.9	34	4
	4	1	7.0	7	7
LPA Erection	2	1	60.0	60	60
	3	18	60.3	183	19
	4	23	118.5	1753	13
Shelter External	1	7	32.8	131	2
	2	15	16.8	104	2
	3	13	71.8	270	3
	4	7	12.3	29	4
Shelter Internal	1	25	16.4	94	2
	2	8	39.4	142	4
	3	8	38.1	125	8
Klystron Adjustment	1	34	9.5	94	1
	2	5	8.0	17	3
	3	3	31.0	51	2
Antenna Alignment	1	22	60.4	720	1
	2	12	11.2	24	1
	3	5	65.2	115	12

B. V3 System.

A performance OMF for the V3 system is defined as set up time in excess of 120 minutes for a combination of all tasks except LPA erection and anchors. Observations were made on 32 setups with 41% (13/32) being performance OMFs. The tasks which according to data collected are the most time consuming are listed out below for the V3 system. These tasks drive the set up times and the possibility of an OMF for the V3 system. These tasks are also the ones from which the most benefit can be derived by making improvements.

a. Azimuth Stake Out: This task was observed 29 times during the test with an average time of 6.9 minutes (Table 4) for completion. The maximum time was 22 minutes or in other words 18% of the maximum allowed time for setup. This task must be accomplished before any other setup task can be started. This is the task that requires the M2 compass from the QRA trailer before the trailer is placed on the site. The data (Table 5) shows that the more people involved in the task the longer it took to finish. It is likely that the more difficult the azimuth determination the more crew members that got involved.

b. Shelter and QRA trailer Placement on the Site: This task was observed 32 times during the test with an average time of 20.3 minutes (Table 4) for completion. The maximum time was 103 minutes or 86% of the 120 minute setup criteria. This task follows azimuth stake out and preceeds the other setup tasks. The data (Table 5) on number of persons involved in the task indicates that more people do not speedup this task.

c. Offloading the Trailer: This task was observed 32 times during the test with an average time of 26.6 minutes (Table 4) for completion. It is important that the average time to complete this task is 22% of the total time allowed for setup of the system. The maximum time recorded was 153 minutes or 33 minutes over the time allowed for all setup tasks not just this one. This task is done in parallel with the antenna setup tasks, so the length of time is not as critical as the first two tasks reviewed. The maximum time is totally out of line and would be a performance OMF. This task is one that can be speeded up by more crew members getting involved (Table 5).

d. Shelter External Set Up: This task was observed 32 times during the test with an average time of 27.9 minutes (Table 4) for completion. The maximum time was 80 minutes or 66% of the 120 minute setup criteria. This task can run parallel with the antenna setup tasks. The data (Table 5) on number of persons involved in the task is inconclusive, but most likely more people can do the task faster. In 84% (27/32) of the observations more than one person was involved in this task.

e. Shelter Internal Set Up: This task was observed 32 times during the test with an average time of 15.7 minutes (Table 4) for completion. The maximum time was 78 minutes or 65% of the 120 minute setup criteria. This task can run parallel with the antenna setup tasks, but requires power hookup to be completed (Shelter External Setup, subtask). The data (Table 5) on number of persons involved show that this is primarily a one person task (72% of the observations) and if more people are involved the task takes more time.

f. Antenna Alignment: This task was observed 26 times during the test with an average time of 24.3 minutes (Table 1) for completion. The maximum time was 205 minutes or 85 minutes longer than the 120 minute setup criteria. This task can not be accomplished until all other setup tasks (except LPA) are completed. The mean time accounts for 20% of the total allowed time line. This task time is not improved by the number of people involved in task performance.

The tasks which consume the most time overall and cause the time line to be as long as it is for the V3 system should include the time for the LPA. There is an overlap of tasks that are critical to the setup time. The LPA is excluded due to the fact that the system can perform its mission without this safety system. The fact is this task is the most time consuming and fatiguing for the V3 operators.

g. LPA erection: This task was observed 31 times during the test with an average time of 49.0 minutes (Table 4) for completion. The maximum time during the regular test was 124 minutes or over the setup criteria maximun. This task can run parallel to the antenna setup tasks. The data (Table 5) on number of persons involved in the task show that in 90% (28/31) of the observations of this task three or more persons were involved in task performance. The more crew members involved and the longer the task takes the greater the effect on the crews ability to perform the tasking that follows.

Analysis of the performance time data has identified the critical tasks listed as the tasks on which procedures, training, and improvements should be concentrated. Data is reported on all the tasks on which data was collected in the tables on the next several pages.

Table 4.
Task Performance Time for Set Up
V3 crews Combined (time in minutes)

Task	Number of Obs	Mean	Std. Dev.	Maximum Value	Minimum Value
Azimuth Stake Out	29	6.9	5.9	22	1
Trailer/Shelter Placement on Site	32	20.3	22.0	103	2
Offload Trailer	32	26.6	30.6	153	4
Attach Ext. Tubes	32	5.7	3.0	15	2
Attach Reflectors	32	6.2	5.6	27	1
Attach Waveguides	32	8.7	7.8	41	1
Antenna Erection	32	9.6	8.9	53	3
LPA Erection	31	49.0	30.2	124	10
Shelter External	32	27.9	17.6	80	3
Shelter Internal	32	15.7	16.4	78	2
Klystron Adjustment	30	5.2	3.6	12	1
Antenna Alignment	26	24.3	41.7	205	2

Table 5.
Task Performance Time V3 Set Up
by Number of Persons Performing the Task
(time in minutes)

Task	Number of People	Number of Obs.	Mean	Maximum	Minimum
Azimuth Stake Out	1	12	3.5	10	1
	2	7	8.6	22	2
	3	10	9.9	20	1
Trailer/Shelter Placement on Site	2	10	18.6	96	3
	3	22	21.6	103	2
Offload Trailer	2	6	38.8	106	6
	3	25	24.2	153	4
	4	1	12.0	12	12
Attach Ext. Tubes	2	6	6.8	10	4
	3	24	5.7	15	2
	4	2	2.0	2	2
Attach Reflectors	2	8	4.4	9	1
	3	22	7.2	27	2
	4	2	2.5	3	2
Attach Waveguides	1	1	1.0	1	1
	2	8	6.1	20	2
	3	22	10.2	41	3
	4	1	3.0	3	3
Antenna Erection	1	8	8.7	18	5
	2	16	10.3	53	3
	3	8	9.1	15	6
LPA Erection	2	2	71.0	97	45
	3	8	49.5	124	15
	4	20	46.3	124	10
Shelter External	1	6	21.0	33	7
	2	14	29.8	80	3
	3	13	26.6	59	10
Shelter Internal	1	23	12.8	50	2
	2	7	24.1	78	3
	3	2	20.0	20	20
Klystron Adjustment	1	26	5.3	12	1
	2	4	4.7	12	1
Antenna Alignment	1	11	35.9	205	2
	2	11	11.4	22	3
	3	3	36.0	85	8

Table 6.
Task Performance Time V3 Tear Down
by Number of Persons Performing the Task
(time in minutes)

Task	Number of People	Number of Obs.	Mean	Maximum	Minimum
LPA Disassembly	2	1	10.0	10	10
	3	10	16.8	25	6
	4	21	18.0	55	7
Lowering Antennas	1	7	4.7	7	3
	2	14	9.4	17	3
	3	10	9.7	23	5
Remove & Store Extension Tubes	2	13	9.1	14	4
	3	19	10.3	50	4
Remove & Store Waveguides	1	6	11.5	29	4
	2	11	8.1	25	2
	3	15	12.9	39	3
Load Trailer	2	4	31.2	46	20
	3	27	20.0	44	9

The V3 system had no OMFs for tear down. The crews on the average took about one hour to tear the system down. The table above indicates that the most time consuming task is loading the trailer. The V3 system has set up tasks that are a problem (i.e. offloading the trailer; shelter internal and external setup; antenna alignment) and will need additional manning unless these tasks can be modified.

The analysis of task data shows that critical task time problems are shared by both V2 and V3 crews. The noted improvements and focus will benefit all 26QD6 operators. The performance data supports the other MANPRINT problems and suggested improvements.

Table 7.
Task Performance Time for Set Up
V2 and V3 Compared (time in minutes)

Task	Number of Obs	Mean	Std. Dev.	Maximum Value	Minimum Value
V2-Azimuth Stake out	24	10.6	12.4	62	1
V3-Azimuth Stake Out	29	6.9	5.9	22	1
V2-LPA Erection	43	50.9	262.6	1753	13
V3-LPA Erection	31	49.0	30.2	124	10
V2-Shelter External	43	35.2	61.7	270	2
V3-Shelter External	32	27.9	17.6	80	3
V2-Shelter Internal	43	24.7	31.4	142	2
V3-Shelter Internal	32	15.7	16.4	78	2
V2-Klystron Adjust	42	10.9	16.3	94	1
V3-Klystron Adjust	30	5.2	3.6	12	1
V2-Antenna Alignment	39	45.9	121.2	720	1
V3-Antenna Alignment	26	24.3	41.7	205	2

Data from the training at Keesler AFB has been combined with RAM data and critical task performance data. The data is summarized in the table on the next two pages. A comparison of each team in the test is possible with this data. The best performing team also had the best school scores. The second best team had ranked fourth as far as training scores. Correlations of this data were non significant. It would appear that training scores do not predict field performance.

Table 8.
Team Comparisons: Training Scores Vs RAM Data
Vs Performance Data

	TEAM 1		TEAM 2		TEAM 3	
	*V21	V31	V22	V32	V23	V33
Training: Overall test average, per team (N = 3), from D6 course at Keesler AFB.						
Mean Score	87.7	86.0	81.3	85.0	89.3	88.0
Std. Dev.	7.5	11.9	10.0	8.9	6.9	12.4
RAM Data*						
Procedure	8	7	2	6	3	5
NTF	4	10	4	7	2	5
Chg. Crew	11	19	13	16	2	17
Total RAM	38	55	27	37	9	40
Performance Data (Overall setup excluding LPA & anchors in minutes)						
Mean Time	314.1	108.7	166.7	173.3	159.0	114.6
Std. Dev.	91.8	42.7	55.4	107.1	41.9	44.5
Performance Time Criteria OMFs						
Setup	6	2	0	4	0	3
Teardown	5	0	0	0	4	0

*RAM: Procedure = problem due to mistake in procedure; NTF = No Trouble Found; Chg. Crew = Chargeable to Crew; Total RAM = number of RAM incidents reported for each van.

The training scores are the average of the block scores received at the D6 course given at Keesler AFB. The scores are aggregated into teams because all the performance data is by team. The RAM data represents the number of crew chargable problems experienced during the test and the total RAM incidents are listed for comparison purposes. The performance data tells how fast the crews accomplished the tasks and how often they failed to meet performance criteria.

Table 8. (continued)
Team Comparisons: Training Scores Vs RAM Data
Vs Performance Data

	TEAM 4		TEAM 5	
	V24	V34	V25	V26
Training: Overall test average per team (N = 3)				
Mean Score	80.7	84.0	87.0	87.7
Std. Dev.	7.6	9.5	10.8	7.3
RAM Data*				
Procedure	6	8	2	3
NTF	6	10	2	5
Chg. Crew	13	18	12	13
Total RAM	37	68	29	38
Performance Data (Overall setup excluding LPA & anchors in minutes)				
Mean Time	262.0	168.6	315.7	220.5
Std. Dev.	108.7	65.8	198.6	76.5
Performance Time Criteria OMFs				
Setup	4	4	5	4
Teardown	4	0	2	3

*RAM: Procedure = problem due to mistake in procedure;
NTF = No Trouble Found; Chg. Crew = Chargeable to Crew.
Total RAM = number of RAM incidents reported for each van.

System Safety

Safety Evaluation.

1. 9.5 ft. Antenna.

The assembly of the 9.5 ft. antenna has several situations where personnel need to extend their reach. There is no ladder or other approved stand available on the AN/TRC-170(V). (Ref: MANPRINT Problem #12, Appendix A). The situations include the following: pins for the upper pedal assembly; support struts for the AZ/EL assembly; roll yoke adjustment; messenger cable installation/removal; adjustment of waveguide connections; loading/unloading the low profile pallet. The rear truss of the 9.5 ft. antenna should be modified to provide safe hand/foot holds for climbing.

Supporting Data: Interview results: 69% (24/35) operators reported needing a ladder. One data collector responded that, when drilling vertical holes with the Pionjar, operators had to stand on something to start the hole due to the length of the drill bit. 69% (24/35) of the data collectors agreed with the need for a ladder. Many persons were observed at various times during the FOT&E climbing on V2 antenna truss assemblies. Reasons were to install camouflage; attach/remove waveguides, etc. Truss frames could be made safer to climb on by minor modifications.
(Reference Appendix B questions: O82, D128, T166)

2. Pionjar.

The auditory noise produced by the Pionjar is damaging to operators' hearing unless the operator wears hearing protectors. (Ref: MANPRINT Problem #13, Appendix A). The Pionjar also produces vibration and in some cases the vibration caused the operator to lose ear plugs while operating the Pionjar.

The Pionjars supplied with the system (AN/TRC-170(V)) were not labeled as to safety or operation. (Ref: MANPRINT Problem #14, Appendix A).

The Pionjars supplied with the system (AN/TRC-170(V)) were not packaged per military specification. The model supplied did not have an operators manual written to military specification. No published findings on equipment durability were obtained prior to the FOE. (Ref: MANPRINT Problem #15, Appendix A). The impact of this support device has not been assessed as to its logistics and general support requirements. The equipment requires gasoline and motor oil (30 or 40 weight non-detergent) for fuel. The Army has established a policy of using diesel fuel for field equipment, causing a burden on the supply system to support this equipment.

Supporting Data: The noise level at the Pionjar is 110+ dB(A). The standard ear plugs are not adequate protection for long term exposure to this noise level. (Sound measurements were taken during FOT&E with a calibrated approved octave band analyzer by MANPRINT staff personnel.) Pionjar inspected in the hands of troops during the FOT&E were painted yellow; had no

safety warning, operating or fuel mixture instruction labels on them; and had no Army standard technical manuals. Incorrect oil was mixed with fuel and caused Pionjar breakdowns during both the pilot and regular tests.

3. Low Profile Pallet.

The loading/unloading procedures for the low profile pallet require the crew members to assume unsafe positions. (Ref: MANPRINT Problem #23, Appendix A). This is particularly true when removing the canvas cover and retrieving the accessory kit.

Supporting Data: MANPRINT personnel observed operators unloading and reloading components of the low profile pallet over the sides rather than off the tailgate of the 2.5 ton truck. Inspection of operator's manuals shows that the only task performance description in which personnel walk along the truck side rails is removal of the canvas pallet cover. In wet or freezing conditions, the specified performance procedures could cause injury. However, attempting to perform the four person load/unload tasks with only three persons could also cause injury (see manpower issues).

4. Mobilizer (M720).

a. Mobilizer Positioning:

The manual positioning of the mobilizer (M720), used to transport the AN/TRC-170(V)2 shelter, is unsafe. (Ref: MANPRINT Problem #04, Appendix A). The mobilizer (M720) used for the AN/TRC-170(V2) cannot be backed up while connected to the prime mover (2.5 ton truck) by the present hitch system. The length of the hitch and its angle while connected make this an unsafe operation. The mobilizer must be driven into position in only a forward manner. The mobilizer could be moved manually if sufficient personnel are available (at least 8 strong persons), but this procedure is not recommended and has a number of unsafe aspects.

Supporting Data:

TASK	% "INADEQUATE" RESPONSE			
	OP	TD	DC	UNIT
Manhandle V2 shelter/ mobilizer	94% (33/35)	92% (11/12)	97% (34/35)	100% (13/13)

Small personnel size - strength factors further aggravate the crew number problems.
(Reference Appendix B questions: O62, O73, T69, D62, U22)

b. Mobilizer Field Safety.

The mobilizer (M720) used for transporting the AN/TRC-170(V)2 system is not adequate for the task and a different system for movement is needed. (Ref: MANPRINT Problem #24, Appendix A).

The weight distribution and balance of the V2 shelter is a problem. (Ref: MANPRINT Problem #35, Appendix A). The electronics and radio equipment of the AN/TRC-170(V)2 system within the shelter are all located upon the roadside. The Air

Force has determined that the shelter is not stable on over a twenty degree side tilt when loaded upon the mobilizer. The AN/TRC-170(V)2 system must be able to be moved into off road area for site set up. The present Mobilizer (M720), with the wheels as fielded, has less than a one foot road clearance, which is not adequate for the mission. The shelter will be used to transport other equipment in a normal tactical environment and will be loaded at or over capacity during off road travel. The use of any vehicle at maximum load capacity in rough terrain is not advisable. It is expected that the rate of break down of the mobilizers will be unacceptable. The potential for accidents resulting in system loss are increased.

The system should be mounted upon a truck for usual non tactical employments of the system. The use of the mobilizer should be restricted to situations requiring air mobility. The system should not continue to use the (M720) mobilizer unless heavy duty wheels are used and cargo restrictions are carefully followed by the system user.

Supporting Data. Questionnaire responses were as follows: 43% (15/35) of operators, 58% (7/12) of test directorate respondents, 74%, (26/35) of the data collectors, and 69% (9/13) of the unit respondents reported problems with the V2 mobilizer. The problem was the disintegration of tires and wheels. Often lug nuts would break allowing wheels to fall off. Usually the problem was with front and rear roadside wheels. There are six mobilizers (M720) being used in the test; four of them were deadlined due to weight related problems (sheared off lug posts). Five of the six had some related damage. None of the damaged mobilizers were returned to service during the test. The Test Directorate stopped their use for safety reasons. Each tire used is restricted to an 1800 pound load limit. The weight on the roadside wheels is (2075 front and 2255 rear) over the safety limits with no unauthorized cargo. The gross weight of the authorized load was 7470 pounds, an overload of 220 pounds. The wheels were weighted with tactical cargo (roadside 2290 front and 2430 rear) and the overall weight (8620 lbs) exceeded safety standards (Ref: Appendix J). It was later contended that no extra gear was authorized to be carried in the shelter. Almost without exception, those responding to interview questions about the mobilizer were in favor of truck mounting for the van or the design/acquisition of a much heavier duty mobilizer. The M720 is good for one thing, to get the shelter on and off of a C-130 or C-141.

(Reference Appendix B questions: 023, 083, 084, T83, T84, D23, D111, D112, D168, U38, U52, 0168, U50,T169)

5. Shelter Environment.

The shelters used to house the AN/TRC-170(V) systems are S-280 (V2) and S-250 (V3). The shelters are painted metal including the floors. Metal floors in a tactical environment are dangerous unless surfaced with nonskid material. The electronic components in the shelters are subject to damage by static discharge. The floor protection needs to include antistatic capability. (Ref: MANPRINT Problem #32, Appendix A).

The noise levels within the shelters exceed minimums for hearing damage, especially in the midrange of hearing (500 to 2K hertz). The overall dB(A) weighted average was in the hearing damage range for both shelters. Hearing protection is required for all persons in the shelters during shelter operation. (Ref: MANPRINT Problem #36, Appendix A).

The operators were observed sitting for extended time periods in the shelters. The lack of provided seating means they used whatever was available (i.e. water coolers, Pionjar box, folding chairs, etc.). The use of inappropriate items for seating increases accident possibilities. The shelters will be used for extended periods of time (SOPs have not been developed for ROCU use) and reduction of loose unauthorized items should be encouraged. (Ref: MANPRINT Problem #44, Appendix A).

Supporting Data: FOT&E field observations showed instances when floors became slippery due to rain entering through open doors and fan gratings (Flushing fan). Discussions with operators and data collectors did not reveal any known injuries from this cause; but the potential remains. (Reference Appendix B questions: D30-36, 030-36, 0139)

Noise levels were measured within the shelters during periods of transmission using an approved, calibrated octave band analyzer, both in a door-open and door-closed configuration. Noise levels were in the hearing damage range for V2 and V3 systems, especially in the 500-2000 Hertz range. The operators and support personnel for the AN/TRC-170 system will suffer profound hearing loss unless adequate hearing protection is provided (Ref: Table 9).

Table 9.
Noise Level Measures
in V2 and V3 Shelters

Shelter door open

Van	Weighted Average	Octave Band Frequencies in Hertz 31.5	63	125	250	500	1K	2K	4K	8K	16K	Hertz
V3	82	78	79	84	80	82	81	74	69	75	71	dB(A)
V2	87	90	80	89	79	83	87	78	72	70	71	dB(A)

Shelter door closed

Van	Weighted Average	Octave Band Frequencies in Hertz 31.5	63	125	250	500	1K	2K	4K	8K	16K	Hertz
V3	83	82	81	86	80	84	87	81	75	75	69	dB(A)
V2	89	90	80	89	80	87	87	78	73	71	71	dB(A)

Note: Measures were taken with shelter door open and with the door closed. The systems were in high power mode.

Questionnaire responses were as follows: 57% (20/35) of operators reported shelter environmental problems. 54% (19/35) of these complained of noise levels when in high-power transmission mode. 50% (6/12) of test directorate personnel and 43% (15/35) of the data collectors concurred in the noise problem assessment. Operators were observed using various objects in the shelter for seating. A potential safety hazard could result from this practice.

6. Shelter Access.

Safe access is required for all systems. The mounting of AN/TRC-170(V) on trucks requires that suitable ladder access be provided for the systems. (Ref: MANPRINT Problem #40, Appendix A). The ladders used during the test did not meet standards (Ref: MIL-STD-1472C). Ladder access should be directly in front of the doors (center of the tailgate) and must have a hand rail. The ladder for access should be part of the fielded system.

Supporting Data: Ladders used during the test for truck mounted shelters (when available) did not meet standards. None were available for the V2's which had been put on 5-ton trucks. Comments received from operators during the test indicated that several persons had fallen from 5-ton truck beds, particularly at night. No specific injuries were attributed to this cause.

7. Lighting for Night Operations.

It is impossible to perform any V2 or V3 antenna setup/teardown operations without some illumination. At desert sites under a full moon, no particular problems were reported. On all occasions with less light, artificial illumination was necessary to perform the following tasks:

a. Site layout/antenna baseplate locating
b. Baseplate emplacement after anchor installation
c. Antenna leg and truss assembling
d. Inserting or removing antenna assembly pins

Supporting Data: Operation in MOPP IV requirements further reduced night operating effectiveness. Tactical light discipline requirements, particularly in an NBC environment, could restrict V2 antenna movement operations to daylight hours. (Effects might be reduced by extensive task practice.)

Health Hazards Evaluation.

The evaluation of health hazards is not within the scope of field testing. The instrumentation and control required to specifically identify hazards are not available. The task must be reduced to the identification of "potential" hazards. The following issues are raised as possible or potential problems.

1. Radiation Hazard.

The effects of long term exposure to microwave radiation are not known. It is assumed that a hazard may exist and exposure should be minimized as much as possible. The following problem works counter to this goal.

The operators (26QD6) of the AN/TRC-170 were not taught proper radiation hazard safety procedures for site selection and set up of the system. (Ref: MANPRINT Problem #16, Appendix A). The training of operators must include practical exercises in site selection, layout, and site set up. The radiation hazard implications should be part of the training. It is recommended that more hands on training be conducted at the school. The manuals should be modified to include specific information on radiation hazards and the areas of hazard.

Supporting Data: The training course at Keesler covered site layout in a lecture only mode. The instruction was confined to antenna orientation and shelter placement. The radiation hazard zone in front of the antennas was not covered in terms of site selection and layout. The radiation from side and back lobes of the antenna was not discussed. The specific hazards of microwave radiation were not taught. The crews will set up and place antennas in a manner that will pose a radiation hazard to persons outside their unit (i.e. shooting across a public road). The crews are not aware of the specific dangers of the radiation and will receive larger levels than are safe.

2. Noise.

The presence of noise in the work environment is both a short term and long term hazard. The noise level in the shelters and the noise produced by auxiliary equipment such as the Pionjar or generators has been identified as a safety problem. The long term exposure to this work environment will produce a disproportionate number of stress related illnesses in the operator/maintainer populations. The hearing damage associated with working in the general area of the system will most likely go undetected in relation to this system. The major noise generation is in the normal speaking range and may cause communication problems for personnel long after direct exposure to the environment (Ref: Table 9).

3. Vibration.

The whole body vibration produced by use of the Pionjar may contribute to future illness problems of the operator population. The vibration impact on the operators can be minimized with proper training on the use of the Pionjar. Operators have not received such training to date. Observation of the field use of the Pionjar would indicate that the operators are taking considerable whole body vibration during operation. No measures of vibration were made during this test.

4. Muscle-Skeletal Stress/Trauma.

The long term effects of lifting excessive weight or pushing heavy objects (mobilizer) will contribute to future muscle-skeletal problems of the operator population. The reduced manning of the crews combined with tasks requiring effort (lifting, carrying, pushing) out of the allowed weight range, as specified in MIL-STD-1472C, will increase the incidence of problems in this group.

Training Evaluation:

This evaluation is organized to correspond to the results section of the USAOTEA Test Report. The analysis is presented in the following sections and in the same order.

Section 1. The primary focus of this section is on the adequacy and accuracy of technical manuals and the distribution of Reading Grade Level of those Technical Manuals.

Data concerning the adequacy and accuracy of Technical Manuals was obtained from four sources:

1. Observations made during one of the AN/TRC-170 Army Operator Courses provided at Keesler AFB for Army Operators.
2. Comments derived from observation of field performance and NETT training by Test Directorate personnel prior to the FOT&E.
3. Comments made by Operators and Maintainers during structured interviews.
4. Comments submitted on DA Form 2028 during the FOT&E concerning Technical Manual Accuracy and Adequacy.

1. System Documentation (Publications) Problems

a. General Publication Concerns

Problems with training documentation were identified from all sources in the data collection effort, except soldier critiques of D6 training provided by Keesler. Given that Operators are responsible for setup, operation and tear-down of AN/TRC-170(V) equipment, information they require must be procedurally oriented. Elimination from the TM of much of the theory and system description together with schematics, wiring (block and signal flow) diagrams and parts description would be a good beginning in reducing the TM size to manageable proportions. While reduction in size of TM is a desirable goal, the Figures (Foldouts) depicting schematic drawings of pieces of equipment (Ref: either V2 or V3 TM chapter 7, FO-1 through FO-19) should be colocated (reduced in size to fit on 8-1/2" x 11" pages) in the TM with the tables (4-1 through 4-19), identify index number, panel marking and type of device, and function. Much to the credit of training aids used by Keesler and NETT, these materials were colocated. Separating panel markings/types of devices from schematic drawings makes each of these materials less useful, especially in an operational environment where table and chair are not available. Requiring soldiers to manually find and then colocate these materials even in a classroom environment tends to inhibit their use and thereby encourages field expedient trial and error efforts to problem resolution. Further, if Operators continue to be prohibited from performing even minimal maintenance tasks, the

two TM chapters concerned with troubleshooting also would not be needed by Operators; however, these chapters are definitely needed by Maintainers.

While the troubleshooting methodology used for the AN/TRC-170(V) is excellent, the documentation used to support this methodology consists of two extremely thick manuals, one of flow diagram fold-outs and a second which contains detailed interpretation of information referenced in the fold-out flow diagrams. Working with two cumbersome documents in a relatively confined area (especially in the V3 shelter) without a table surface and chair makes what could have been a straightforward mental task possess very taxing physical aspects. It would be desirable to create separate troubleshooting documents for each system component where relevant fold-out flow diagrams and detailed flow chart reference material are collocated for easy access. It requires unusual intelligence to unravel the complexity of some of the flowcharts, especially the longer foldouts. Many of these are almost too large to be handily used inside the shelters (V3 particularly).

Supporting Data. General comments concerning the adequacy of the TM were obtained during structured interviews. 32% (12/38) of the Operators/Maintainers indicated that the TM was not clear, contained redundancies, lacked specificity, was not concise or contained contradictions or material out of sequence. 29% (11/38) indicated that there was a problem looking up things in the TM; two recommended development of an index for cross referencing and tabs for the TM. 32% (12/38) indicated that the TM was not rugged enough for an operational environment, 47% (18/38) indicated TM was losing pages and the need for a firm binder; 34% (13/38) indicted the TM was too large with many parts not needed. Whether Operators become authorized to perform minimal maintenance (and hence require access to troubleshooting materials), 14% (5/35) of the Operators indicated the need for secure storage of the TM in the shelter. Of all operators who tried to use the troubleshooting flowcharts, 26% (9/35) reported them hard to use. 43% (15/35) of the operators considered alternate equipment diagnostic procedures inadequate. Test directorate respondents reported operators lax in use of the TM's. 75% (9/12) rated publications as deficient in logistic support information; 17% (2/12) thought information was not clearly presented: 25% (3/12) said, "Manuals have too much unneeded information; 17% (2/12) said, "The manuals are confusing and information is hard to find". The three MANPRINT test directorate staff personnel agreed with the "confusing and hard to find" description of the manuals. The lack of effective indexing, compounded by the use of identical illustrations for assembly and disassembly task performance descriptions, in two separate chapters, compounds this effect. In some chapters, the manuals appear to be hastily assembled using a "cut and paste" method. 83% (11/12) of the test directorate staff found it difficult to locate specific problem information in the TM. 43% (5/12) said, "manuals consist of too many volumes and are not

cross referenced." 50% (6/12) didn't think the flowcharts were easy to follow. There was 100% agreement that the TM was too large and frail to be used and survive in a typical Army field environment. Suggestions, "make it smaller by summarizing the significant material, reduce the size of the pages, reinforce each pages binding to reduce tear-out problems." "The manual needs to be small with an 'operations summary'". 9% (3/35) of the data collectors reported finding inaccuracies in the flowcharts. 75% (9/12) of the test directorate respondents found flowchart errors during fault diagnosis.
(Reference Appendix B questions: O38, O39, T38, T39, T61, T99, T146, T151, T152, T161, 168, D38, D39, D110, U37, U49, U60)

b. Content Related Documentation Concerns.

1. Systems Interface Training in Loading COMSEC Equipment

The operators/maintainers lack training on the interaction of COMSEC equipment with AN/TRC-170 operation. (Ref: MANPRINT Problem #20, Appendix A). D6 and NETT training emphasized procedures to be followed in individual vans and did not focus much on the need or coordination procedures required among all communicating elements during "variable loading". Coordination of the manual contents with COMSEC procedures on variable loading is recommended. Specific emphasis in this coordination should be determination of adequacy of documented procedures in addressing system interface steps. Procedures should be modified if warranted by review. During training on use of COMSEC equipment, greater emphasis should be placed on system interface aspects of the variable loading procedures.

Supporting Data: Some operational mission failures occurred because of a lack of required understanding of system component interactivity. Operators themselves stated that more training was required on TED 1 and 2, 25% (7/28) and COMSEC gear in general, 31% (11/35). 37% (13/35) of the operators reported problems with these components. 25% (3/12) of the test directorate personnel listed a requirement for more COMSEC interface training; 26% (9/35) of the data collectors agreed; unit respondents made no specific comments on COMSEC interface training needs. 50% (6/12) of the test directorate respondents considered COMSEC procedures incomplete. During structured Operator interviews, 25% (7/28) reported problems in loading TEDs and 29% (8/28) reported problems with the VINSON of either loading or dropping variables. While these reports may well represent only COMSEC equipment problems, training and/or system documentation appears to be a valid concern even at the end of the FOT&E. During the final structured interview 49% (17/35) of the operators indicated the need for additional training with the TEDs and COMSEC equipment.
(Reference Appendix B questions: O11, O15, V49, T82, T171, T174, D110, D14, D15)

2. Orderwire Control Unit Training

During training on Orderwire Control Unit use, greater emphasis should be placed on procedures to follow to unlock the electronic bridge. Short of shutting down and then powering up the system, no procedures discussed by Operators appeared to work consistently. Again coordination of the manual contents with COMSEC procedures on variable loading is recommended. Specific focus should be on the adequacy of procedures to be followed when the electronic bridge does lock up. Since the field expedient procedures may not be available or provide secure communications in an operational environment, orderwire procedures should be modified if warranted by review.

Supporting Data: In the structured operator interviews 46% (16/35) reported problems with the electronic-bridge in the orderwire locking up. As a result, secure voice communications needed by system elements (vans) during configuration change or when a new variable is to be loaded was prohibited. As this problem was a reported concern by only 31% (11/35) in the final interview, it is not clear whether procedures for orderwire use were developed later in the FOT&E or whether field expedient procedures such as use of HF and FM radios were used more to effect configuration or variable loading changes.

c. Specific Content Related Documentation Change Recommendations.

Identification and subsequent correction of content errors in the trouble shooting procedures could be cost-effectively determined by documentation of the problems as they are noted during system operation. Unit emphasis on providing this documentation as they occur in field exercises will lead to improved troubleshooting procedures.

The following changes to TM 31R2-2TRC170-1-1 and TM 31R2-2TRC170-11-1 are recommended:

1. Table 4-20: Prime Power Application
   a. After step 1, insert the step: "Check that vents are open"
   b. After step 11, insert the step: "Shut phase-select switch OFF"

Supporting Data: During structured interviews an Operator indicated there had been two overheats causing the RF amplifier to malfunction because the operator forgot to open vents. While this step was taught as part of D6 training, TM documentation does not include this step.

2. Table 4-29: LOS Mode Set-Up
   The switch settings for ANT and DL for the TROPO toggle switch in the BITE PANEL are as labeled when operating in TROPO mode but reversed when operating in LOS mode (and not so labeled).

Supporting Data: A special cautionary step should be inserted in steps for the LOS Mode Set-Up procedure.

3. Table 4-27: Preliminary Set-Up for TROPO Mode
   Modify the first two sentences in step 8 to read: "Locate plastic laminated klystron tuning chart and verify that the serial number on the chart and klystron are the same. Locate the nearest frequency....."

Supporting Data: The problem was identified as a potential safety hazard.

4. Table 4-28: Turn-On and Checkout for TROPO Mode
   Add to the end of step 15: "; the RF OUTPUT-TROPO kilowatt meter should increase."

Supporting Data: Two DRIVE ADJUST settings will give an indication of "Green" on the DRIVE meter, but with one the RF OUTPUT-TROPO kilowatt meter does not increase. This is the incorrect DRIVE ADJUST setting.

5. Table 4-26: Gain Equalization Procedure
   After step 9, add: "NOTE: If adjustment cannot be made to midscale for any channel, perform adjustment to lowest channel value that is obtained for all."

Supporting Data: The manuals lack information on default setting.

6. Troubleshooting Procedures
   This section of the manuals needs review for accuracy and consistency. The changes required are too many and too involved for complete coverage in this presentation. Three examples follow:

   a. FO 57 (Sheet 1 of 2)
      1). To the fourth box down add: "if can't be done, continue". 2) In the box which says: "Go to PARA 6-9", add: "if error still exists, go back to START"

   b. FO 70
      Based on discussion with a Maintainer during the structured interviews, it appears that this entire procedure needs to be rewritten and the CESE message generator circuitry may need to be modified. An initial problem with the steps outlined in this flowchart is that there may be a problem with the VOCU regardless whether the VOCU LED is or is not lit.

c. Problem Identification in Downconverter Assembly

During structured Operator/Maintainer interviews one Maintainer indicated that there was a problem with DC power circuits leading to the Downconverter but only the low voltage power supply (LVPS) alarm fault light was indicated. Raytheon took two days to get the Downconverter fixed; there was no problem with the LVPS. Troubleshooting diagrams in the TM did not help. One way this problem might be remedied would be to first modify the CESE message generator circuitry followed by modification of the problem identification troubleshooting flow charts and supplementary interpretation material.

Supporting Data: The troubleshooting methodology used for the AN/TRC-170 is excellent. However, based on rather limited exposure to or experience with these materials, it appears that there are errors in content, both of commission and omission.

d. Reading Grade Level.

This section is concerned with the adequacy and accuracy of technical manuals and the distribution of Reading Grade Level of the Technical Manuals. One way of improving the usability of documentation provided is to assure that it is "readable". In order to make this judgement the Army has adopted the Flesch-Kincaid formula (Ref: DOD MIL-M-387848) for determination of reading grade level of text. Major variables included in this index are sentence length and number of syllables used in words. In order to assess the readability of the TMs, several pages were sampled from each TM as well as eight pages from the Mitre Interface Manual.

Data concerning the adequacy and accuracy of Technical Manuals was obtained from four sources:

1. Observations made during one of the AN/TRC-170 Army Operator Courses provided at Keesler AFB for Army Operators.
2. Comments derived from field observation and NETT training by Test Directorate personnel prior to the FOT&E.
3. Comments made by Operators and Maintainers during structured interviews conducted during the FOT&E.
4. Comments submitted on DA Form 2028 during the FOT&E.

Data Summary.

V2 Manual:
Preliminary Technical Manual (PTO 31R2-2TRC170-11) Radio Terminal Set AN/TRC-170(V)2 Part Number 951100-5 NSN 5820-01-148-3976, (FULLY VERIFIED), issued by Raytheon Company, Lexington, Massachusetts, under authority of the Secretary of the Air Force, dated 1 June 1986.

Table 10.
Reading Grade Level for Sampled Pages from AN/TRC-170(V)2 Technical Manual

SOURCE	TYPE OF MATERIAL	READING GRADE LEVEL
Chapters 1-4 for V2		
Pages		
1-20	Equipment description	9.60
4-63	Operating procedure (in Steps)	7.08
4-70	Operating procedures (in Steps)	6.16
4-73	Operating procedures (in Steps)	5.40
4-102	System description	9.72
Chapter 5 for V2		
Pages: 5-31, 5-51, 5-116, 5-145, 5-184		
	Theory of Operation	11.45
	Overall Average	8.24

V3 manual:
Preliminary Technical Manual (PTO 31R2-2TRC170-1) Radio Terminal Set AN/TRC-170(V)2 Part Number 951100-4 NSN 5820-01-148-3977, (FULLY VERIFIED), issued by Raytheon Company, Lexington, Massachusetts, under authority of the Secretary of the Air Force, dated 1 June 1986, updated 20 Nov. 1985.

Table 11.
Reading Grade Level for Sampled Pages
from AN/TRC-170(V)3 Technical Manual

SOURCE	TYPE OF MATERIAL	READING GRADE LEVEL
Chapters 1-4 for V3		
Pages		
1-35	Equipment description	10.66
1-44	Equipment description	9.47
4-49	Operating procedures	7.56
	(in Steps)	
4-63	Operating procedures	9.14
	(in Steps)	
4-65	Operating procedures	7.13
	(in Steps)	
Chapters 5 for V3		
Pages: 5-34, 5-89, 5-157, 5-197, 5-202		
	Theory of Operation	9.97
	Overall Average	8.99

TRI-TAC Equipment Interface Plan for AN/TRC-170, written by Rene J. Dube, Jr. and Paul M. Hotzel of The Mitre Corporation (McLean, Virginia), Sponsored by U.S. Army contract number F19628-84-C-0001, manual dated May 1985.

Table 12.
Reading Grade Level for Sampled Pages
from TRI-TAC Equipment Interface Plan for AN/TRC-170(V)

Interface manual pages 18; 25; 56; 64; 77; 85; 102; 129.	
System/Equipment Description	12.04

Review of the above data would indicate that equipment description and operating procedures are probably well within the reading ability of todays MOS 26Q; Theory of Operation and system description material more suited to Maintainers (MOS 29M) tend to be more difficult to read. Examination of the uncommon word list for pages which deal with Theory of Operation appear to contain many monosyllabic system specific acronyms and several multisyllabic technical words specific to the AN/TRC-170 system. Generally improved readability of materials concerned with Theory of Operation and system description will come by constructing shorter sentences. Substitution of multisyllabic system specific words with monosyllabic words is generally not possible nor appropriate. Once soldiers learn the system specific words, the words become conceptually less complex.

Section 2.

This section focuses upon the number of tasks and distribution of those tasks test players were unable to perform

during the conduct of the FOT&E. Throughout the FOT&E there were no tasks that could not be performed at least some of the time. In addressing this concern, it is relevant to discuss those tasks which did present clear difficulties in performing. Tasks selected for inclusion on this section are those where in either of the structured interviews at least 30% of the Operators indicated some problems, delay in diagnosis or repair was more than one day or where no clear resolution to the problem evolved during the FOT&E. Reference is made to the critical task lists in the Personnel Section of the MANPRINT Results.

Data used in this section is composed of comments made by test participants to structured interviews as well as RAM data.

1. Systems Interface Training in Loading COMSEC Equipment

The operators/maintainers lack training on the interaction of COMSEC equipment with AN/TRC-170 operation. (Ref: MANPRINT Problem #20, Appendix A). D6 and NETT training emphasized procedures to be followed in individual vans and did not focus much on the need or coordination procedures required among all communicating elements during "variable loading". During training on use of COMSEC equipment, greater emphasis should be placed on system interface aspects of the variable loading procedures.

Supporting Data: Operators stated that more training was required on TED 1 and 2, 25% (7/28) and COMSEC gear in general, 31% (11/35). 37% (13/35) of the operators reported problems with these components. 25% (3/12) of the test directorate personnel listed a requirement for more COMSEC interface training; 26% (9/35) of the data collectors agreed; unit respondents made no specific comments on COMSEC interface training needs. 50% (6/12) of the test directorate respondents considered COMSEC procedures incomplete. During structured Operator interviews, 25% (7/28) reported problems in loading TEDs and 29% (8/28) reported problems with the VINSON of either loading or dropping variables. While these reports may well represent only COMSEC equipment problems, training and/or system documentation appears to be a valid concern even at the end of the FOT&E. During the final structured interview 49% (17/35) of the operators indicated the need for additional training with the TEDs and COMSEC equipment.
(Reference Appendix B questions: O11, O15, V49, T82, T171, T174, D110, D14, D15)

2. Orderwire Control Unit Training

Specific focus should be on the adequacy of procedures to be followed when the electronic bridge does lock up. Since the field expedient procedures discussed may not be available or provide secure communications in an operational environment, orderwire procedures should be modified if warranted by review.

During training on Orderwire Control Unit use, greater emphasis should be placed on procedures to follow to unlock the electronic bridge. Short of shutting down and then powering up the system, no procedures discussed by Operators appeared to work consistently.

Supporting Data: In the structured operator interviews 46% (16/35) reported problems with the electronic-bridge in the orderwire locking up. As a result, secure voice communications needed by system elements (vans) during configuration change or when a new variable is to be loaded was prohibited. This problem was a reported concern by 31% (11/35) in the final interview.

3. LPA Assembly/Disassembly

During early field exercises and pilot test, it became apparent that soldiers had not received D6 training on the assembly/disassembly of the LPA. Some of the soldiers did received some experience on this task during field exercises prior to the start of testing. The NETT training and Pilot Test exercises added to their experience. It did not appear that the LPA could be safely assembled/disassembled using three soldiers as prescribed and the Test Directorate issued specific warnings about the conduct of this task, crews were instructed to use four persons. During the test this task proved only marginally safe with four or five soldiers. Continued Operator concern for performing these tasks with three soldiers combined with operator injuries led Test Directorate personnel to suggest alternate procedures and/or modified LPA equipment might be needed to make these possible to accomplish safely. Preliminary analysis of procedures suggest that if lengths of two of the three guy-wires were measured from their point of connection midway up the LPA pole to the point of ground anchoring, then these two guy-wires could be anchored prior to beginning erection. This would permit two soldiers to hold the LPA bottom into the baseplate as the third soldier walks the pole up. It is recommended that the feasibility of these possible solutions be explored and, if appropriate, alternate training procedures be developed and trained. Analysis suggested that it might be desirable to modify the LPA baseplate to a hinged design.

Supporting Data: While all Operators indicated in the final structured interview that with their training and experience to date they were SQT qualified on these tasks, the "OJT" training provided did not completely alleviate training deficiencies observed. Indeed, during the FOT&E there were at least two cases where Operators got sprained wrists or a bruised shoulder as they were walking up the assembled LPA pole because the pole slipped out of the baseplate. In both structured interviews of Operators, 86% (30/35) indicated that "any three" soldiers could not safely erect the LPA; 46% (16/35) interviewed volunteered that at least four soldiers would be needed to perform the erection safely. Disassembly of the LPA is easier; however, 66% (23/35) indicated that "any three" soldiers could not safely disassemble the LPA. 26% (9/35) of the operators suggested that any fourth person available should be used to help out.

4. Problem Identification in Downconverter Assembly

The troubleshooting procedures and training for the Downconverterneed to be reviewed and possibly modified. The BITE support for this component may also require modification.

Supporting Data: During structured Operator/Maintainer interviews one Maintainer indicated that there was a problem with DC power circuits leading to the Downconverter but only the low voltage power supply (LVPS) alarm fault light was indicated. Raytheon took two days to get the Downconverter fixed; there was no problem with the LVPS. Troubleshooting diagrams in the TM did not help. One way this problem might be remedied would be to first modify the CESE message generator circuitry followed by modification of the problem identification troubleshooting flow charts and supplementary interpretation material.

5. Efficient Drilling and Seating Anchors with Pionjar

The Pionjar operation, maintenance, and safety procedures are not part of the current Army training system for the 26QD6 MOS. (Ref: MANPRINT Problem #04, Appendix A). The Pionjar is a useful tool but like any power tool dangerous unless used properly. The lack of training of the operators constitutes a safety hazard for the personnel and equipment involved. During the FOT&E, wide variance in times to drill anchor holes was observed. Part of this variance is due to differences in ground hardness and moisture content as well as types of Pionjar bits (e.g. standard, star) and anchors used. The lack of operation and maintenance procedures training will contribute to the reduction of the useful life of the Pionjar. Pionjar training is not shown in MOS 26QD6 plan of instruction (POI). Pionjar training was not given at Keesler AFB. If the Pionjar continues to be the device of choice for drilling holes and sinking anchors, it would be desirable to develop a task summary to include Standards, Conditions and Performance Steps for Pionjar Operation/Maintenance. Included in this task summary should be criteria for selection of type of Pionjar bit and anchor to use as well as number of personnel to operate the equipment given crew member sizes and ground hardness. This task summary should be used to direct Pionjar operation/maintenance training either as part of D6 or unit level training for MOS 26QD6 personnel.

Supporting Data: Questionnaire responses show that 42% (5/12) of the test directorate stated operators were not properly taught to use the Pionjar. One data collector commented there should be Pionjar training. (All Pionjar training was given midway during the test by special arrangement with the equipment distributor.) In the final structured interview, 40% (14/35) of the operators indicated the need for other anchors (e.g. rock, arrowhead, smaller, etc.).

6. Problems Maintaining Constant Generator Output Voltage

It is desirable to introduce some means whereby power output of generators is kept more constant during operation and where phase-in switches are used to allow generator switching without power interruption.

Supporting Data: During the final structured interview, 34% (12/35) of the operators reported problems with the klystron due (in their opinion) to power surges.

7. Maneuvering V2 Mobilizer into Position

Soldiers will need to receive training on maneuvering a mobilizer into position. The crews also are in need of training on towing, backing, and convoy procedures. Providing at least a portion of this training in conjunction with other site layout tasks should lead to acquisitions of the needed mission-oriented skills. Assuming the AN/TRC-170(V)2 continues to be viewed as tactically feasible, operational deployment by aircraft in a wartime environment will necessarily involve use of some type of mobilizer. The 5 ton trucks, which are perfectly suitable for peacetime transport, probably will not be available at Non-CONUS sites at a time of war. While the suitability of the mobilizer used during the FOT&E is seriously open to question, the Army does have a M832 heavy duty mobilizer which could be used. Since the height of the S-280 shelter loaded on the M832 mobilizer is currently too high to allow C-130 cargo plane transport, it would be desirable first to explore whether the M720 mobilizer could be upgraded to be operational. While equipment which is not reliable or safe obviously should not be used, deployability is of key importance to a communications system which may be called upon to operate anywhere in the world.

Supporting Data: Questionnaire responses were as follows: 43% (15/35) of operators, 58% (7/12) of test directorate respondents, 74% (26/35) of the data collectors, and 69% (9/13) of the unit respondents reported problems with the V2 mobilizer. Almost without exception, those responding to interview questions about the mobilizer were in favor of truck mounting for the van or the design/acquisition of a much heavier duty mobilizer. The M720 is good for one thing, to get the shelter on and off of a C-130 or a C-141.

8. Interface (Auxillary) Equipment Training

In this section discussion focuses on the AVOW, ROCU and DS/VT telephone. D6 training at Keesler did provide minimal training in use of each of these pieces of equipment. As noted in the summary comments for Block 2 Keesler training on the RLGM, RMC and LSCDM, the role of the AVOW, ROCU and DS/VT in the system could have been better identified through explanation of how they are used in one or two sample system configurations. Except for the ROCU, training consisted of the instructor talking through procedures. At least for training, it would be desirable to have these procedures outlined in written form for reference by Operators at a later time. Identifying the role of these auxiliary pieces of equipment and, in the cases of the DS/VT and AVOW, providing step-oriented procedures on use would reduce the likelihood that training deficiencies contribute to ineffective use of this equipment.

Supporting Data: Operator comments made during interviews indicated several problems in use of the AVOW and ROCU. 14% (5/35) of the operators indicated the AVOW would ring when not in use and 14% (5/35) indicated that with the ROCU, they could ring and talk only to their shelter, but not the distant end.

9. Planning and Supervisory Personnel Equipment Orientation Training

Planning and supervisory personnel of the units receiving the new equipment were not given required new equipment orientation training. (Ref: MANPRINT Problem #20, Appendix A). In as much as Operators will not generally know much about the overall system configuration being used, direction they receive needs to be clearly communicated and error free. The mode for this communication is the use of the Crew Assignment Sheet (CAS) (sometimes referred to as "cut sheet"). Comments made by players as well as data collectors throughout the FOT&E indicated that throughout the FOT&E planning and supervisory personnel (SYSCON) provided operators with CAS which were in error and on occasion provided "guidance" on system configuration that would not work, and in most cases operators knew it. Review of this concern indicated that while planning staff and operations personnel did have a communications background they had received virtually no training and minimal orientation to the AN/TRC-170(V). This was determined by review of the NETT POI and monitoring of training. Failure to provide proper training creates the possibility of the entire network failing and the respect of operators for their supervisors is undermined.

Supporting Data: 77% (10/13) of the unit respondents thought unit personnel not of 26Q MOS should also receive AN/TRC-170(V) training. 92% (12/13) of these also believed battalion and brigade operations staff personnel should get AN/TRC-170(V) training, at least a familiarization course. (Reference Appendix B questions: T82, V37, U58, V59, U60)

10. ROCU Operation

A major purpose of the ROCU is to permit Operators to monitor the shelter from a distance. In a wartime environment this provides Operators a measure of protection from enemy fire likely to be targeted to the AN/TRC-170(V) radio frequency (RF) emissions. The use of the ROCU also obviates the need for the operator to remain in a relatively noisy shelter environment. As pointed out previously, Keesler did provide some training on ROCU check out, but little on the operational use of the ROCU. As evidenced from responses to structured interviews conducted with operators throughout the FOT&E, the equipment showed faults when there were none and in some cases communication could take place only between the ROCU and shelter to which it was wired into but not the distant end. Both as part of D6 and unit training operators should be trained on use of the ROCU. Without formal ability to use the ROCU, following installation and setup the shelter may tend to be abandoned, with a consequent potential for an OMF.

11. System Set-Up, Installation and Maintenance With MOPP Gear

Prior to conducting any of the structured interviews with operators, MANPRINT personnel observed installation on sites where use of MOPP gear was directed. Based on observations the soldiers performance of tasks was marginal. If soldiers were actually in an environment where MOPP protective gear was necessary, all would have suffered exposure to some contaminate. Were observations and reports based on full operational use of MOPP gear, conclusions would have been even more severe than those now reported. It became clear in one night setup operation that as installation activities began, operators "labored" with MOPP gear, especially MOPP IV gear (protective clothing as well as rubber gloves and protective mask). As installation progressed, operators sought and secured permission not to be required to use MOPP gear on breaks. During the times MOPP gear was worn and operators were actively engaged in installation (assembling and erection of the V2 antenna and Pionjar operation) activity was noticeably slower than without MOPP gear. Operators were heard breathing heavily under masks, complaints of restricted vision were made and upon removal of masks during breaks, faces appeared flushed and full of perspiration. When protective gloves were removed during breaks, hands appeared wet and "pruned-up". In conversations, operators indicated that restricted vision concerns were increased especially for people who normally wore glasses and that some of the breathing difficulties may have been due to using masks with clogged filters. These impressions were generally confirmed in later structured interviews with Operators.

Supporting Data: 94% (33/35) indicated installation tasks could be performed effectively with MOPP II gear, but only 43% (15/35) felt this could be done with MOPP IV gear. 60% (21/35) indicated that configuration setup could be performed effectively with MOPP IV gear and 37% (13/35) felt maintenance could be effectively performed. In both setup and maintenance, comments indicated that the gloves would reduce finger sensitivity; for both sets of tasks seven operators indicated performance times would significantly increase when wearing MOPP gear.

12. Site set up concerns with radiation hazards.

The operators (26QD6) of the AN/TRC-170 were not taught proper radiation hazard safety procedures for site selection and setup of the system. (Ref: MANPRINT Problem #19, Appendix A). The operators did not learn proper site layout and set up procedures prior to going to the field with the AN/TRC-170 equipment. The training course at Keesler covered site layout in a lecture only mode. The instruction was confined to antenna orientation and shelter placement. It is recommended that more hands on training be conducted at the school. The manuals should be modified to include specific information on radiation hazards and the areas of hazard.

Supporting Data: This observation was obtained by inspection of operational field sites. Sites were found where the radiation hazard zones were much smaller than those depicted in AN/TRC-170 publications. Sites were found without radiation hazard zones marked or incompletely marked. Some antennas were found (Hill 4) pointing directly at the only site access road, which passed within 10 meters (or less) of the antenna front. Discussion with crews revealed that they did not know hazard zone shapes/dimensions. All of the crews had to be instructed on the size and shape of the radiation hazard zone following pilot test. Part of the operators problem in performing this task was due to lack of a 100' tape measure. Pacing off distances resulted in several components being incorrectly located and subsequently moved or compensated for in a field expedient manner.

Section 3.

In review of the tasks for most systems involving humans, some minimal physical and mental abilities are required. As part of an evaluation of system effectiveness, optimizing system performance makes it desirable to assess whether special abilities are needed.

In order to assess whether special physical or mental abilities were required to setup, operate and tear-down the AN/TRC-170, data was obtained from unstructured field observations during early field and pilot exercises as well as the structured interviews with operators midway through and at the end of the FOT&E.

Data Summary.

In both of the structured interviews Operators were asked where the issue is size and physical strength, can any three soldiers who hold the MOS 26QD6 perform the following tasks?

- Erect the LPA
- Disassemble the LPA
- Unload the low profile pallet
- Erect the 9.5 foot antenna
- Manually maneuver the V2 mobilizer into position
- Maneuver the QRA into position
- Install a complete set of anchors (maximum of 22 anchors)
- Get the TRC-170(V)2 operational in 5 hours

During the final structured interview, Operators were also asked to indicate whether there were safety hazards associated with setup, operation or tear-down of components of the 9.5 foot and QRA antennas, LPA, Pionjar operation and the sufficiency of space in the V2 and V3 for setup, operation and monitoring. Detailed responses to these questions are found in Appendix B. For most of equipment components or activities referenced, less than 50% of operators felt that any three could safely operate or handle those components. In both sets of structured interviews to these questions, there were a total of 97 volunteered responses which addressed number of crew members as the major reason for unsafe operation and handling difficulties. Only five responses addressed physical soldier size as a concern; three of those responses indicated the Pionjar was difficult for a short person. The two remaining responses indicated that big soldiers would have difficulty working in the V3 shelter. In some cases, difficulties for any three soldiers to operate or handle the equipment addressed their awkwardness, clumsiness or difficulty in reaching (i.e. insert/remove pins or camouflage). Most problems relating to physical size concerns could be addressed by including a ladder with system equipment.

Section 4.

Document Problems Noted In setup/tear down.

a. Set-Up/Tear Down Related Tasks. Using the TM (Preliminary Technical Manual (PTO 31R2-2TRC170-11) Radio Terminal Set AN/TRC-170(V)2) as a guide, problems included in this section relate to training concerns in use of equipment found in the V2 or V2 shelter (see Chapter 4).

1. Circuit Card Assembly (Line Replaceable Unit)

During both structured interviews, operators indicated the need to reseat or have cards replaced on several pieces of equipment. Current doctrine does not authorize operators to perform card replacement. With the current Unit TO&E, allocation of one Maintainer per unit, and with points in the communication network more distant than for earlier communication systems, unless operators are trained and authorized to perform some of the more simple maintenance activities like card and fuse replacement, and tightening loose connections, system DOWN time will increase. As a minimum operators would need to receive training concerning:

a. Card Organization--keep known good cards (in Risk Kit) separate from potentially defective cards.

b. Card Handling--hold cards only on outer edge to prevent static charge from our body being transferred to the card.

c. Card Replacement--sensitivity to differences in the pins in back of cards that are used in seating and to "feel" rather than force the cards when replacing/reseating.

Supporting Data: The pieces of equipment operators reported needing replacement, together with the number of operators reporting the need are presented below:

- Control Logic Assembly (CCA/LRU) (4)
- High Voltage Power Supply (11)
- Klystron (12)
- TROPO Modem Modulator (7)
- TROPO Modem Demodulator (5)
- COMSEC gear in general (13)
- Low Voltage Power Supply (3)
- Loop Group Multiplexer (4)
- Group Modem (3)
- Trunk Group Multiplexer (2)
- Orderwire Control Unit (11)
- Heater Assembly (12)
- Remote Orderwire Control Unit (ROCU) (12)

When Operators were asked whether they were SQT qualified to remove/replace shelter components 80% (28/35) indicated YES. Out of apparent frustration 9 of those 28 soldiers volunteered that they were not authorized to do much and could do more if given Risk Kits and authorization.

2. Preventive Maintenance Checks and Service (PMCS) Training

No PMCS training was provided either as part of the D6 training at Keesler or by NETT. Over the short term, there may be no adverse effect of failing to perform PMCS; however, a greater number of malfunctions can be expected down the road.

PMCS should be obtained or developed by CECOM and included as part of D6 and unit training. With over seven years of development work on the AN/TRC-170(V) for the Air Force, needed PMCS should already exist.

Supporting Data: In structured interviews 21% (6/28) of the operators indicated that either PMCS books were not in the van or exist only for DGM equipment.

3. Klystron Tuning Training

Keesler D6 and NETT training were extremely explicit on the need and reason for following these procedures; nevertheless during NETT training an operator error in tuning the klystron was directly related to failure to read the procedures, he depended on memory. In at least one case during the FOT&E, it was necessary to change a klystron. Since it is hard to see how formal training on these cautionary steps could be improved, it is recommended that there be unit emphasis on reading and following directions in the TM.

Supporting Data: In structured interviews 67% (2/3) of the maintainers indicated that the Klystron was very difficult to work on. 34% (12/35) of the operators reported problems with the Klystron.

b. Installation Related Tasks

Again using the TM (Preliminary Technical Manual (PTO 31R2-2TRC170-11) Radio Terminal Set AN/TRC-170(V)2) as a guide, problems included in this section relate to training concerns in site preparation and antenna erection procedures (see TM Chapters 2 and 3).

1. Site Layout

The operators did not learn proper site layout and set up procedures prior to going to the field with the AN/TRC-170 equipment. (Ref: MANPRINT Problem #17, Appendix A).
The training course at Keesler covered site layout in a lecture only mode. The instruction was confined to antenna orientation and shelter placement. The overall layout of the field site including generators, tents, Command Post, and security was not taught at all. The students were not given any practical field experience in this area. The crews performances of the task using the rope template for site layout was observed to be weak in spite of training provided by NETT.

Supporting Data: Observations of early antenna setup exercises showed that crews were not following TM task performance steps. When queried, it was learned that site stake-out and measurement procedures for the V2 site had not been practiced at Keesler AFB. 25% (3/12) of the test directorate respondents did not consider crews SQT qualified in this task. 17% (6/35) of the data collectors agreed.
(Reference Appendix B questions: O50, T75)

2. Use of Pocket Transit

The operators were reported to be trained (interview with the TRADOC representative) in the use of the compass known as the "Pocket Transit" (M2 compass). (Ref: MANPRINT Problem #33, Appendix A). This compass is not the one used as a common task compass (standard lenzatic compass). The operators initially had difficulty using the Pocket transit for site layout. The M2 is read through a mirror system or to untrained operators appears to read "backwards". Operators have used an informal on-the-job learning to get to a point where the pocket transit could be consistently used. The test environment is the only reason this occurred so fast.

Supporting Data: Interview responses were as follows: 25% (3/12) of the test directorate respondents thought crews weak in azimuth determination; 33% (4/12) of these answered that operators were not SQT qualified. (On one occasion, a site was set up backward, 180 degree out of alignment). 15% (2/13) of the unit personnel interviewed believed operators needed more site layout training; 15% (2/13) of the unit personnel considered operators not SQT qualified in the task of azimuth determination. Two data collectors wanted operators to be given more site layout training. 17% (6/35) didn't think operators could perform azimuth determination to SQT standards with the M2 compass. Azimuth stake out was observed 24 times during the test with an average time of 10.6 minutes (Table 1) for completion. The maximum time was 62 minutes or in other words 26% of the maximum allowed time for setup. This task must be accomplished before any other setup task can be started. Several interviewed persons suggested substitution of the standard lenzatic compass in lieu of the M2. The lenzatic is sufficiently accurate, costs about 80% less, and more persons are already trained to use it.

3. Pionjar Operation/Maintenance

The Pionjar operation, maintenance, and safety procedures are not part of the current Army training system for the 26QD6 MOS. (Ref: MANPRINT Problem #04, Appendix). The Pionjar is a useful tool but like any power tool dangerous unless used properly. The lack of training of the operators constitutes a safety hazard for the personnel and equipment involved. During the FOT&E, wide variance in times to drill anchor holes was observed. Part of this variance is due to differences in ground hardness and moisture content as well as types of Pionjar bits (e.g. standard, star) and anchors used. The lack of operation and maintenance procedures training will contribute to the reduction of the useful life of the Pionjar. Pionjar training is not shown in MOS 26QD6 plan of instruction (POI). Pionjar training was not given at Keesler AFB. Given the potential safety concerns in using a large, heavy, and noisy piece of equipment and the importance of proper anchoring of the LPA and V2 antenna, it is imparative that training for this piece of equipment be developed as soon as possible.

Supporting Data: Questionnaire responses show that 42% (5/12) of the test directorate stated operators were not properly taught to use the Pionjar. One data collector commented there should be Pionjar training. (All Pionjar training was given midway during the test by special arrangement with the equipment distributor (Berema))

4. Generator Operation/Maintenance

At both the D6 training provided at Keesler and NETT training provided at Fort Huachuca, commercial electricity was used to power the AN/TRC-170 equipment. Operator training provided by the unit and FOT&E experience led most soldiers to report during interviews that they were SQT qualified on this task. Since most operational settings in which the AN/TRC-170 will be used will not have commercial power available, there should be continued assurance that operators receive generator operation/maintenance training either as part of the D6 training or at unit level.

5. Wave Guide Attachment

While attachment of wave guides to antenna and shelter ports is in itself a fairly small part of the antenna erection task, it is critical to successful mission completion. At Keesler, training did not provide any practical exercises for this task. The task was practiced during the NETT training. That training combined with experience gained during the FOT&E apparently assured this concern never became a major problem.

Supporting Data: 43% (15/35) of the operators in the final structured interviews reported major problems with the waveguide and messenger cable interface with the system. 69% (24/35) of the operators indicated that providing a ladder would make performing in some situations safer, e.g., in making attachment and adjustment of the messenger cable and inserting pins connecting reflector petals and the hub. Also, including extra "O" (rubber)-rings in the Risk Kit would be helpful.

6. Antenna Alignment (AZ/EL Adjustment)

Early in the test during field observations, the process of antenna alignment appeared to involve special system knowledge. In-as-much as D6 training provided by Keesler did not involve any exercises where soldiers had to align antennas they raised to establish communication, this task was not trained. Training provided by NETT did involve antenna adjustment for a short LOS shot. However, as alignment is often unnecessary on LOS shots, this training lacked realism and probably denied operators meaningful feedback on the adequacy of the steps they performed on this task, feedback that would be gained in a TROPO shot. Experience attained during pilot and field exercises prior to the FOT&E appeared to serve as good training on this task. Since it is probably not cost-effective to conduct a TROPO shot exercise during D6 training, this training must be programmed during unit directed field exercises.

Supporting Data: On both structured interviews conducted with operators, 97 to 100% indicated they were SQT qualified on antenna adjustment. Antenna alignment for the V2 system was observed 39 times during the test with an average time of 45.9 minutes (Table 1) for completion. The maximum time was 720 minutes or three times longer than the 240 minute setup criteria. Antenna alignment for the V3 system was observed 26 times during the test with an average time of 24.3 minutes (Table 4) for completion. The maximum time was 205 minutes or 85 minutes longer than the 120 minute setup criteria.

7. LPA Assembly/Disassembly

During early field exercises and pilot test, it became apparent that soldiers had not received D6 training on the assembly/disassembly of the LPA. Some of the soldiers did received some experience on this task during field exercises prior to the start of testing. The NETT training and Pilot Test exercises added to their experience. It did not appear that the LPA could be safely assembled/disassembled using three soldiers as prescribed and the Test Directorate issued specific warnings about the conduct of this task, crews were instructed to use four persons. It is recommended that the feasibility of new solutions be explored and, if appropriate, alternate training procedures be developed and trained. Analysis suggested that it might be desirable to modify the LPA baseplate to a hinged design.

Supporting Data: While all Operators indicated in the final structured interview that with their training and experience to date they were SQT qualified on these tasks, the "OJT" training provided did not completely alleviate training deficiencies observed. Indeed, during the FOT&E there were at least two cases where Operators got sprained wrists or a bruised shoulder as they were walking up the assembled LPA pole because the pole slipped out of the baseplate. In both structured interviews of operators, 86% (30/35) indicated that "any three" soldiers could not safely erect the LPA; 46% (16/35) interviewed volunteered that at least four soldiers would be needed to perform the erection safely. Disassembly of the LPA is easier; however, 66% (23/35) indicated that "any three" soldiers could not safely disassemble the LPA. 26% (9/35) of the operators suggested that any fourth person available should be used to help out.

8. Maneuvering V2 Mobilizer Into Position

RAM data together with reports from operators during the final structured interview indicated that there are difficulties with operation of the mobilizers used during the FOT&E. The mobilizers present unique problems with the shelter weight imbalance and have experienced durability problems (wheels and lug nuts came off four of the six (M720) mobilizers during moves between sites). To perform their tasks, soldiers will need to receive training on maneuvering a towed and loaded mobilizer into position. Providing at least a portion of this training in

conjunction with other site layout tasks should lead to acquisitions of the needed mission-oriented skills.

c. Interface With Other Equipment

Training related problems included in this section relate to analogue and digital voice orderwire (AVOW & DVOW) used to communicate between different shelters in the system as well as auxiliary equipment such as the ROCU, RLGM, DS/VT telephones and RMC.

DS training at Keesler did provide minimal training in use of each of these pieces of auxiliary equipment. As noted in the summary comments for Block 2 Keesler training on the RLGM, RMC and LSCDM, the role of the AVOW, ROCU and DS/VT in the system could have been better motivated through explanation of how they are used in one or two sample system configurations. Except for the ROCU, training consisted of the instructor talking through procedures. At least for training, it would be desirable to have these procedures outlined in written form for reference by Operators at a later time.

Supporting Data: Operator comments made during interviews indicated several problems in use of the AVOW and ROCU. 14% (5/35) of the operators indicated the AVOW would ring when not in use and 14% (5/35) indicated that with the ROCU, they could ring and talk only to their shelter, but not the distant end.

Section 5.

Overall Description of Training

All AN/TRC-170 Army 26Q MOS Operators who have participated in the FOT&E (N = 35) received 4 weeks of formal training in the AN/TRC-170 Army Operator course offered by the Air Force at Keesler AFB in Biloxi, MS between March and August 1986. In addition, most of these soldiers received supplemental and review training provided by the New Equipment Training Team (NETT) and 2 hours of instruction by Pionjar manufacturers at Fort Huachuca. Except for one class of four soldiers, each Keesler course trained eight soldiers with MOS 26Q. Class sizes for NETT operator supplemental and review training was approximately 12 per class.

Brief Description of AN/TRC-170 Army Operator Course Provided at Keesler

In order to facilitate this training, instruction was divided into five blocks comprised of lecture/discussion and hands-on exercises. For the first four blocks, soldiers were administered several Progress Checks (PC) throughout block training, a final Block Test and hands-on exercises using procedures which generally appeared in the Technical Manuals (TMs). Progress Checks (PC) and Block Tests were multiple choice questions with five alternatives each in most cases; 5 questions per PC, and 25 questions per Block Test. Following

completion of each block of instruction and testing, soldiers were required to provide a written critique of instruction provided. While PC's and Block Tests did serve as criteria for assessing performance in each block, they have limited value as a basis for evaluating training procedures. Questions asked were developed from material trained; however, as will be noted, it was not always clear that the material trained (or how it was trained) was necessary for an AN/TRC-170 Operator to know.

The training evaluation presented below is based on a rather detailed review of training provided in terms of what material was trained, training aids used, and the adequacy of Technical Manuals.

Throughout the data analysis, training evaluation has been directed by two underlying guidelines: 1) Training should be practically (procedurally) oriented rather than theoretical or simply factual; and 2) training should provide experiences which are as close as possible to tasks that are performed on the job. The "transfer of training" literature in the behavioral sciences provides sufficient justification for the second guideline. Some have argued that training with a theoretical as opposed to practical orientation gives the learner a better understanding of the material (system) being trained and will thereby increase competence in dealing with new and unexpected problems. Experience tends to show that this increased competence comes only after prolonged experience with the material (system). Development of "how to use" skills initially increases confidence with the material (system) and provides a context within which the "whys" of the system are more quickly appreciated. Both in their critiques provided after each block of D6 training at Keesler and in response to the structured interviews, soldiers expressed the desire for more hands-on exercises. In the first interview, in response to the question "Should there be more classroom training?" 74% (26/35) of the operators interviewed responded NO and 71% (25/35) volunteered that there should be more hands-on and practical exercises.

Detailed description of Army Operator D6 Skill Identifier training together with specific evaluative comments is provided in Appendix C, Tables 1 through 5. Based on review of these data alone several recommendations related to training follow:

Block 1

- Seventeen soldier critique responses indicated concern about lengthening training time; five specifically requested more theory; two indicated more laboratory training. Some additional time orienting soldiers to system specific vocabulary would have been helpful.
- Talking through interpretation of system oriented functional block diagrams for different configurations would be useful.

- Talking through functional block diagrams (modified signal flow diagrams) for specific pieces of equipment has minimal value for Operators; this is theory-oriented knowledge and is not procedurally oriented; for Maintainers inclusion of this training has greater relevance.

Block 2

- Five soldier critique responses indicated the need for more hands-on training.
- For operations training on the LGM, GM and TGM, switch setting adjustments need to be incorporated into a procedural sequence to facilitate soldier learning; a sample procedural sequence training aid is provided in Appendix C, Table 10.
- Talking through functional block diagrams (modified signal flow diagrams) for specific pieces of equipment has minimal value for Operators; this is theory-oriented knowledge and is not procedurally oriented.
- After soldiers have developed system functional block diagrams from system specifications (as homework exercises), detailed worked out solutions should be passed out and discussed with soldiers.
- Several practice worksheets should be routinely distributed for soldiers to work out several Base Band Patch Panel wirings for different sets of system specifications.
- Training on auxiliary DGM equipment such as Ring Generator, RLGM, RMC and LSCDM was minimal and their potential role in a system configuration were not well motivated; discussion of examples would be helpful.

Block 3

- Schematic drawings of equipment colocated with an index and description of parts in training aids used provides a good orientation to equipment not found in TMs.
- Training with the RAM could have been considerably more effective if it could have been utilized with a raised antenna in a communicating system.
- Laboratory training with encryption devices was practical and procedural for individual shelters; however, since these materials are mostly classified, periodic unit refresher training is recommended. Training did not emphasize procedures with these devices that involved coordination between shelters.

Block 4

- Schematic controls and indicators drawings for different pieces of equipment with colocated index to numbered parts in training aids used provides a good orientation to equipment not found in TMs.
- Talking through functional block diagrams (modified signal flow) for specific pieces of equipment has minimal value for Operators.

- Instructor pointed out problem with TROPO toggle switch in BITE PANEL--when operating in LOS, switch setting for ANT and DL are reversed; as a minimum, labeling for switch should indicate difference--would minimize confusion for Operators if internal wiring was changed so that UP indicated ANT, down DL regardless whether operating in TROPO or LOS.
- Procedures in the TM performed with equipment provided procedurally relevant hands-on experience.

Block 5

- Seven soldier critique responses indicated training time was good.
- Requiring soldiers to perform BBPP wiring and DGM switch settings for several system configurations provided soldiers with good procedurally oriented training. Had these specifications been provided on crew assignment sheets rather than requiring soldiers to construct system functional block diagrams would have provided more job-oriented training. Construction of system functional block diagrams is an activity seemingly more oriented to G-3 who prepares crew assignment sheets; four soldier critique responses indicated hands-on training time was good.
- QRA erection/disassembly provided good task oriented, procedurally relevant training.
- V2 antenna erection activity to the A-frame level was good; however, it would have been better had complete assembly/disassembly been possible.
- Exercises used to train troubleshooting methodology were good; however, since Operators are currently authorized to perform very little maintenance activity, for the most part this training is appropriate only for Maintainers (MOS 29M).

Instructors for all training blocks appeared competent concerning the AN/TRC-170(V) system and were willing to answer questions when asked.

After D6 training at Keesler AFB, soldiers PCSd to Fort Huachuca to the 526th TROPO Unit. In the summer and early fall 1986, these soldiers' duty assignments became increasingly AN/TRC-170(V) related. During this period, Test Directorate personnel had increasing opportunities to observe largely by field observations and thereby formulate preliminary impressions about the adequacy of the Keesler training in preparing Operators to setup/tear-down and make the AN/TRC-170(V) operational. Through these observations it became clear that there were many areas from site layout through initial setup where Keesler training was deficient.

DISCUSSION

MANPRINT is a comprehensive technical effort to provide a bridge from weapon system and equipment design, development, and production to the related concerns pertinent to: Manpower, Human Factors Engineering, Personnel, System Safety, Health Hazards, and Training.

MANPRINT treats the soldier as a component of system performance and reliability. It seeks to assure that system design is geared to "arm the soldier". MANPRINT seeks to defeat the all too prevalent approach of "What you see is what you get". In other words, when the system was designed, the manpower, personnel, and equipment needs were aggregated and the Army was put in the position of juggling its limited manpower and personnel capabilities to meet the need of an already designed system.

One of the policy pronouncements (AR 605) is that MANPRINT will be used to integrate combat, training, and materiel development with personnel resources and capabilities throughout the life-cycle of developmental, non-developmental, and product improved items.

The test results show that the AN/TRC-170 system has three major areas of deficiency. In the Manpower area the crew size and number of maintainers is not adequate for mission performance. The critical task performance data indicates that setup and teardown of the V2 system and setup of the V3 system fails to meet criteria (an Operational Mission Failure) forty percent of the time. The training of the operators and maintainers was inadequate for mission performance.

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APPENDIX A

MANPRINT PROBLEM SUMMARIES

Purpose

The stated purpose of the MANPRINT scoring conference was to assess the seriousness of the identified problems and determine priorities for correction. The conference also served the test community as a means of communicating the results of the test on the AN/TRC-170 systems.

Procedures

The participants in the conference were all invited to comment on the problems reviewed. The problem criteria ratings were determined by a majority of the voting participants. Voting members were as follows:

1. OTEA Human Factors Specialist (Dr. S. E. Bowser)
2. OTEA Operational Test Director (1LT Paul Chelbo)
3. TRADOC (TSM) representative (Roger A. Kidd)
4. CECOM representative (Robert J. Marone)
5. TECOM representative (Richard J. Hervert)

The problems were reviewed in numerical order beginning with problem number 001. The problems were reviewed as to content and recommended solutions. The criteria used are given on the next page. The criteria assigned are recommendations only and the consensus of the group was to not vote on correction priorities. The correction priorities are the best estimate of the OTEA Human Factors specialist only and do not represent a group consensus.

Conference Results

The results of the MANPRINT Scoring Conference held Jan 13, 1987 have been entered into the problem summaries that follow. The problem priority for each problem represents a majority vote of the participants. During the conference several problems were eliminated and several combined into one issue. The problem statements are being retained for reference only on these changed items. The problem priority criteria were changed by group consensus and the criteria on the next page represent the changed criteria.

The overall manpower problem of crew size (3 versus 4 person) was voted upon by the group. The priority given was "A" for finding a solution for the AN/TRC-170 crew size shortage. There are several specific manpower problems listed that may be solved by means other than additional personnel. The group consensus was that additional crew person is required for effective operation of the system.

Problem Priorities

A. The deficiency has a significant impact on human performance, leading to a high probability of mission failure, damage to the AUE, or injury to personnel.

B. The deficiency has a significant impact on human performance, leading to a high probability of degraded mission capacity.

C. The correction of the deficiency will significantly enhance the operability and/or maintainability of the system.

D. The shortcoming could be corrected by a hardware or software change or can be compensated for through training.

E. The shortcoming has minimal impact on mission. Correction will enhance human performance.

Correction Priorities

1. Problem must be corrected in production models. If units are already fielded field modification must be made ASAP.

2. Problem must be corrected in production prior to fielding of additional systems.

3. Problem must be corrected no later than the first system upgrading after fielding.

4. Problem should be corrected if economically possible.

Problem Number: 001

Problem Title: The manning for the AN/TRC-170(V2) is three persons but four person lifts are required for loading/unloading of the low profile pallet (9 & 1/2 Ft. antenna system).

MANPRINT Category: Manpower

Priority: A 2

Information Sources: Air Force manning of the AN/TRC-170; The manning called for in the Technical Manuals; The 26QD6 operators opinions; Human Factors observations; Lifting and carrying standards from MIL-STD-1472C, paragraphs 5.9.11.3.1 - 5.9.11.3.9

Description of Problem: The unloading/loading of the low profile pallet for the V2 system antenna is unsafe to do with three persons (AN/TRC-170 V2 crew size). The weights that must be lifted and carried exceed MIL-STD-1472C maximums for three persons. The time specifications for system employment are not safely obtainable with the three person crews (assume average physical size personnel). The unit (Heavy Tropo Company) does not have other personnel available (TO&E) to support the crews in the field to reduce or eliminate this problem. The system can not be set up with two person crew making the system unavailable if any crew member is injured or otherwise unavailable. Due to the fact that these units may set up in isolated locations non 26Q and/or supervisory personnel may not be readily available.

Implications: The crews will be subject to potential short term injuries such as back strain, muscle strain, contusions, abrasions, and broken bones. The long term effects include stress related illness and reduction in retention of these personnel. The AN/TRC-170(V2) may suffer Operational Mission Failure due to this problem.

Statistics: Initially the minor accident rate was high for the V2 crews. The crews made many fatigue related mistakes and morale was low. The operators (26QD6) were interviewed and the average crew size recommended for the V2 system was four persons with some recommendations of up to six person crews.

Potential Solutions: The crew size could be increased by the addition of a maintainer (29M or 29S) to add the persons to meet unit requirements. There will be individuals who are above average in size and physical strength making three person crews possible. There will also be those that are smaller requiring four person crews. The procedures for the truss assembly can be modified to reduce the weight lifted by disassembling the truss on the pallet with the probable increase of setup/teardown times.

Problem Number: 002

Problem Title: The AN/TRC-170 V2 & V3 systems include two vehicles. Army regulations require two persons per vehicle, but there are only three crew members.

MANPRINT Category: Manpower

Priority: B 2

Information Sources: Army regulations; Unit SOP(s); Observations of supervisory personnel; Human Factors observations; Highway safety standards.

Description of Problem: The present crew size is three persons per system. Each system has two vehicles assigned as prime movers. Army regulation and highway safety standards call for two persons (driver & assistant driver) for trips of longer than ten hours. The unit SOP(s) Army-wide require a second person (assistant driver) when the vehicle is towing to act as a ground guide (both vehicles in V2 & V3 are used to tow equipment). It is sound safety policy to require two persons per truck for convoy situations.

Implications: The peacetime employment of the system will require that additional personnel be supplied by the unit during movement and exercise employments. The situation in wartime will most likely be overlooked. This brings up the potential loss of the system due to driver fatigue and/or other single driver accident problems. The crew size places the unit in the position of violating safety rules or not getting the system to the field in a timely manner.

Statistics: The list of applicable AR(s) is being researched. The civilian safety standards have sufficient accident statistics to support two drivers per vehicle for all commercial trucker going cross country.

Potential Solutions: The crew size for both systems should be increased to four persons. The fourth person does not necessarily have to be from the 260 MOS. It is recommended that an additional maintainer such as a 29M or a 29S be added to each crew solving both the manpower and maintenance allocation problems.

MANPRINT

Problem Number: 003

Problem Title: The three person manning for each AN/TRC-170 does not provide enough personnel to meet tactical manning requirements. (i.e. radio operation and/or perimeter security)

MANPRINT Category: Manpower Priority: B 2

Information Sources: The opinions of unit supervisory personnel, AN/TRC-170 crews; Test Directorate Personnel; Human Factors observations; Field tactical doctrines.

Description of Problem: The employment of the AN/TRC-170 systems is going to include situations where one or two systems are set up, isolated physically from all other military units. If there are two systems the manning calls for seven persons (three in each crew and a supervisor) and if only one unit, the manning will be three or four persons depending on the location of the supervisory NCO. Tactically the crews must man the radio with at least one person at all times, man a Command Post radio at all times, and provide site/perimeter security 24 hours a day. There are not enough personnel assigned to the system to accomplish these requirements.

Implications: The crew will suffer extreme fatigue trying to meet all these requirements in the tactical situation. The result will be potential loss of the use of the system due to operator error and/or failure of site security.

Statistics: The 26QD6 operators interviewed and 83% stated the V2 crew was not large enough in tactical circumstances and 74% agreed that the V3 manning requirements for the tactical situation was not large enough. The supervisory and planning personnel all (100%) agree crew size should be increased to meet unit tactical demands. The test directorate were interviewed and (83%) personnel also reported a need for increased crew size. The data collectors were interviewed and 63% stated that tactical crew should be increased to meet manning requirements.

Potential Solutions: The unit TO&E should be increased to provide additional personnel to satisfy these manning requirements. The additional personnel do not have to be 26Q MOS personnel. It is recommended that additional maintenance (29M or 29S) be considered as additions to meet manpower needs.

MANPRINT

Problem Number: 004

Problem Title: The manual positioning of the mobilizer (M720), used to transport the AN/TRC-170(V2) shelter, is unsafe.

MANPRINT Category: Human Factors Priority: A 1

Information Sources: Human Factors observations; MIL-STD-1472C paragraphs 5.9.11.4; Test participant comments.

Description of Problem: The mobilizer (M720) used for the AN/TRC-170(V2) cannot be backed up while connected to the prime mover (2&1/2 ton truck) by the present hitch system. The length of the hitch and its angle while connected make this an unsafe operation. The mobilizer must be driven into position in only a forward manner. The mobilizer could be moved manually if sufficient personnel are available (at least 8 strong persons), but this procedure is not recommended and has a number of unsafe aspects.

Implications: The crews will be subject to potential short term injuries such as back strain, muscle strain, contusions, abrasions, and broken bones. The long term effects include stress related illness and reduction in retention of these personnel. The AN/TRC-170(V2) may suffer Operational Mission Failure due to this problem.

Statistics: Initially the minor accident rate was high for the V2 crews. The crews made many fatigue related mistakes and morale was low. The operators (26QD6) were interviewed and 94% of them were of the opinion that the mobilizer could not be moved manually by the present crews without additional help. The data collectors (97%) and test directorate personnel (92%) agreed. The supervisory personnel stated that a minimum of 5 persons is required to do this task.

Potential Solutions: The shelter could be mounted upon a truck instead of the mobilizer. The use of the M720 in its present configuration should be discontinued.

MANPRINT

Problem Number: 005

Problem Title: The Lightning Protection Assembly (LPA) requires four persons for safe erection/disassembly.

MANPRINT Category: Human Factors Priority: B 1

Information Sources: Human Factors observations; Opinions of the operators and test directorate personnel; DA Pam 385-16, System Safety Management Guide.

Description of Problem: The LPA erection procedures call for four persons (crew size is three persons). The procedures ask for one person holding the base plate, one walking the mast up, and two on guywires to control the mast. Given the current equipment and less personnel than are called for, a situation is created during which the mast may fall in an uncontrolled manner.

Implications: The LPA is erected next to the AN/TRC-170 antennas and shelter. An uncontrolled fall could damage either portion of the system. The personnel are also potentially endangered by the possible uncontrolled falling of the LPA mast.

Statistics: The all test participants (operators, supervisors, data collectors, and test directorate) recommended four person crews for LPA erection/lowering tasks. Human Factors personnel have observed numerous problems during erection including more than 10 uncontrolled falls of these masts. In one case an operator had the mast fall onto his shoulder causing a painful injury.

Potential Solutions: The current base plate should be replaced with a hinged baseplate. The training system should demonstrate correct erection/disassembly procedures to all 26QD6 personnel during specialty training. The crew manning level should be increased to assure adequate personnel for safety.

MANPRINT

Problem Number: 006

Problem Title: The Pionjar operation, maintenance, and safety procedures are not part of the current Army training system for the 26QD6 MOS.

MANPRINT Category: Training Priority: A 2

Information Sources: AR 70-1, System Acquisition Policy and Procedures; MIL-STD-882B, System Safety Program Requirements; Human Factors observations.

Description of Problem: The Pionjar operation, maintenance, and safety procedures are not part of the current Army training system for the 26QD6 MOS. The Pionjar is a useful tool but like any power tool dangerous unless used properly. The lack of training of the operators constitutes a safety hazard for the personnel and equipment involved. The lack of operation and maintenance procedures training will contribute to the reduction of the useful life of the Pionjar.

Implications: The time needed to set anchors for the AN/TRC-170 will be increased due to the training lack. The Pionjar will have a shorter useful life in support of the system. The accident rate for Pionjar operators will be increased.

Statistics: The operators reported anchors and the setting of anchors as a major problem for the AN/TRC-170 system. During the test six Pionjars were disabled due to improper fuel mixtures. Three Pionjar drive rods were bent during the test. In two cases system set up was greatly delayed by the lack of an operational Pionjar.

Potential Solutions: Provide training for potential operators of the Pionjar. The training could be handled at the unit level with appropriate TRADOC support.

Problem Number: 007

Problem Title: The anchors (duckbills) provided for use with the 9 & 1/2 ft. antenna system are only one size and at least two sizes are required (includes LPA anchors).

MANPRINT Category: Human Factors

Priority: B 1

Information Sources: Human Factors observations; Opinions and observations of operators and test directorate personnel. Results of Air Force system tests in 1980.

Description of Problem: The diameter of the duckbill portion of the supplied anchor is larger than the pilot hole drilled by the Pionjar with the supplied drill bit. The anchor is designed to hold in soft ground and can be driven in such ground. The difficulty comes in trying to use the anchor in hard or rocky ground. The supplied anchor is not shaped to aid in the driving process (Pionjar drive rod often punches through them). The present anchor design is also excessively expensive.

Implications: The employment of the anchors is severely limited and difficult unless it is restricted to geographic areas with soft ground (an unsound tactical limitation). The time involved in setting anchors increases to totally unacceptable amounts of time when they are employed in hard ground. The fatigue and stress levels of the crews are increased and thus system set up times are extended. The system cannot be set up with out anchors.

Statistics: The setting of anchors has taken as long as 19 hours for 12 anchors. The test participants all agree that a change is required to make the system tactically usable. Sixty-three percent of the operators and field data collectors in the test think the anchors should not be used in the tactical situation.

Potential Solutions: The present anchors could be used given an assortment of sizes to use depending upon soil conditions. The system developer should review the anchors already on the market and attempt to find a more employable system than the one selected. A less specialized anchor design would also reduce the cost of the individual anchors.

Problem Number: 008

Problem Title: The anchors (duckbills) provided for use with the LPA are only one size and at least two sizes are required.

MANPRINT Category: Human Factors	Priority: B 1

This problem combined with problem number 007 dealing with the anchors for the V2 antenna system. The only difference in the anchors is the cable attachment.

Problem Number: 009

Problem Title: The drive rods of the Pionjar are being driven through anchors and getting stuck in the anchors holes causing a great amount of time and effort to be expended to retrieve them.

MANPRINT Category: Human Factors

Priority: C 1

Information Sources: Human Factors observations; Observations and comments of operators and test directorate personnel.

Description of Problem: The fact that the anchors are too big has brought about a secondary problem. The drive rod used to drive the anchors is being forced through the anchor and in numerous cases has become stuck in the hole with the anchor serving as a restraining collar. This occurs in hard or rocky soil making retrieval of the drive rod difficult.

Implications: The time and effort expended to retrieve these rods further adds to the stress and time demands of the undermanned AN/TRC-170 crews. The drive rods themselves have been damaged (bent) by the use of wenches and sledge hammers to attempt removal of the embedded rods. The long term usefulness of the system may be impacted by the loss of anchor drive rods.

Statistics: So far in the test four rods have been bent during attempts to remove them. The man-hours exceed 8 hours per incident.

Potential Solutions: The addition of Pionjar tools for digging would aid the situation since even with correctly sized anchors this problem could occur. The system developer is also encouraged to investigate alternate means of anchor placement.

MANPRINT

Problem Number: 010

Problem Title: The location of the accessory kit (includes the pocket transit) on the low profile pallet is in the middle on the bottom (the pocket transit is the first item needed for site layout).

MANPRINT Category: Human Factors

Priority: E 4

Information Sources: AN/TRC-170 TM for the V2 system; Human Factors observations; Operator comments.

Description of Problem: The location of the accessory kit (includes the pocket transit) on the low profile pallet is in the middle on the bottom of the pallet. The pocket transit is the first item needed for site layout. The crew must remove the canvas cover from the pallet and push antenna parts out of the way to retrieve the kit.

Implications: The creation of unnecessary and difficult tasks reduces crew efficiency. The retrieval process requires crew members to assume awkward and precarious positions to get to the accessory kit. Crew injury is possible as a result of this location. The crew may also choose to not use the difficult-to-get compass thus causing set up and alignment errors.

Statistics: Sixty-three percent of the V2 operators recommended that the location be changed. All of the V2 crews moved the kit to either the truck cab or the shelter by the midpoint of the test without direction from persons outside the crew.

Potential Solutions: The accessory kit should be placed in the shelter near the door or in the truck cab area for easy access.

Problem Number: 011

Problem Title: The location of the accessory kit (includes the pocket transit) on the QRA trailer is difficult to access (the pocket transit is the first item needed for site layout).

MANPRINT Category: Human Factors | Priority: E 4

Information Sources: AN/TRC-170 TM for the V3 system; Human Factors observations; Operator comments.

Description of Problem: The location of the accessory kit (includes the pocket transit) on the QRA antenna is behind the frame and under the canvas. The pocket transit is the first item needed for site layout. The crew must remove the canvas cover from the trailer and push trailer supports out of the way to retrieve the kit.

Implications: The creation of unnecessay and difficult tasks reduces crew efficiency. The retrieval process requires crew members to force trailer parts in order to get to the accessory kit. Equipment damage is possible as a result of this location. The crew may also choose to not use the difficult-to-get compass thus causing set up and alignment errors.

Statistics: Fifty-one percent of all the operators recommended that the location be changed. Seventy-five percent of the crews moved the kit to either the truck cab or the shelter by the midpoint of the test without direction from persons outside the crew.

Potential Solutions: The accessory kit should be placed in the shelter near the door or in the truck cab area for easy access.

MANPRINT

Problem Number: 012

Problem Title: The assembly of the 9 & 1/2 ft. antenna has several situations where personnel need to extend their reach; there is no ladder or other approved stand available on the AN/TRC-170.

MANPRINT Category: Safety | Priority: C 2

Information Sources: The system PLL; Human Factors observation; Comments of operators and test directorate personnel.

Description of Problem: The assembly of the 9 & 1/2 ft. antenna has several situations where personnel need to extend their reach. There is no ladder or other approved stand available on the AN/TRC-170. The situations include the following: pins for the upper pedal assembly; support struts for the AZ/EL assembly; roll yoke adjustment; messenger cable installation/removal; adjustment of waveguide connections; loading/unloading the low profile pallet.

Implications: The use of field expedient methods by crews will involve unstable and dangerous platforms such as water carriers and fuel drums. The antenna structure will be climbed and equipment pieces not intended for standing upon will be used. The main danger is injury to personnel because of the use of these unstable platforms. Equipment may also be damaged by dropping and/or stresses that were not designed for such as climbing up the truss assembly.

Statistics: Sixty-three percent of the operators reported observing personnel climbing or reaching in a dangerous manner. One operator broke his finger in the process of releasing the support struts for the AZ-EL assembly. Numerous reports were received concerning the dropping of antenna pieces/parts due to reaching and/or climbing.

Potential Solutions: Provide a stand as standard equipment issue for the AN/TRC-170(V2). It is recommended that at least a three foot height stand or ladder be supplied.

Problem Number: 013

Problem Title: The standard hearing protection (ear plugs) is not adequate to protect the Pionjar operators.

MANPRINT Category: Safety

Priority: A 2

Information Sources: MIL-STD-1472C paragraph 5.8.3; Human Factors observation; MIL-STD-1474B Noise Limits for Army Materials, paragraph C-7.

Description of Problem: The auditory noise produced by the Pionjar is damaging to operators' hearing unless the operator wears hearing protectors. The Pionjar also produces vibration and in some cases the vibration caused the operator to lose ear plugs while operating the Pionjar. The noise level at the Pionjar is 110+ dB(A). The standard ear plugs are not adequate protection for long term exposure to this noise level.

Implications: Operators will experience long term loss of hearing acuity and may suffer complete loss of hearing in some frequency ranges.

Statistics: The noise level is 110+ dB(A) at the Pionjar (during drilling) and the 85 dB(A) range is a circle 25 feet in diameter around the Pionjar.

Potential Solutions: The operators should be use a better hearing protection device such as the ear muff style protectors.

Problem Number: 014

Problem Title: There are no safety warnings on the Pionjar as required.

MANPRINT Category: Safety | Priority: A 1

Information Sources: MIL-STD-1472C paragraphs 5.5.1 -5.5.6; Human Factors observations; TECOM TOP 10-2-508 Safety and Health Hazard Evaluation - General Equipment.

Description of Problem: The Pionjars supplied with the system (AN/TRC-170) were not labeled as to safety or operation. The model supplied did not have an operators manual written to military specification.

Implications: The lack of safety warnings can lead to accident and labels are required by military standard.

Statistics: Safety warnings have been placed on the currently fielded Pionjars. No new manuals have been received. The operators (94%) report feeling able to operate the Pionjar after the training, but still forget the safety precautions. The labels supplied have not stayed on the Pionjars.

Potential Solutions: The proper labeling should be supplied for the already fielded Pionjars. The procurement system should assure that all additional deliveries of the Pionjar include the proper labels/warnings. Correct manuals should be obtained. The labels should be securely affixed to the equipment.

MANPRINT

Problem Number: 015

Problem Title: The Pionjar has not been properly militarized.

MANPRINT Category: Safety

Priority: C 1

Information Sources: MIL-STD-1472C paragraphs 4.9 and 4.10; Human Factors observations; TECOM TOP 10-2-508 Safety and Health Hazard Evaluation - General Equipment.

Description of Problem: The Pionjars supplied with the system (AN/TRC-170) were not packaged per military specification. The model supplied did not have an operators manual written to military specification. No published finding of the equipment durability were obtained prior to the FOE. The impact of this support device has not been assessed as to its logistics and general support requirements. The equipment requires gasoline and motor oil for fuel (not a regular field supply item).

Implications: The Pionjar is currently required to set up the antenna system in support of the AN/TRC-170. The system would have an OMF without it. The durability and supply characteristics of the Pionjar must be assessed.

Statistics: Six Pionjars were unavailable due to maintenance problems during the test. The supply system issued improper oil for the oil/gas mixture required causing some Pionjar failures. The crews in some out sites had to obtain regular gasoline from retail sources to operate the Pionjar.

Potential Solutions: A separate test of the Pionjar is needed. The device should also be required to meet military packaging and labeling standards. The logistics issue needs review.

MANPRINT

Problem Number: 016

Problem Title: The rear (truss) clamp assembly on the 9 & 1/2 foot antenna binds when the antenna is set up at the 15 ft. height.

MANPRINT Category: Human Factors

Priority: C 1

Information Sources: Human Factors observations; Operator comments.

Description of Problem: The rear (truss) clamp which locks down the bearing ball on the end of the truss assembly binds. The problem occurs when the antenna is set to the 15 ft. height versus the 10 ft. height. The clamp cannot be closed without lifting the loaded baseplate, a job that is both heavy and dangerous.

Implications: The operators may be injured and/or the antenna damaged. The worst case would be that the rear truss would slip out of the baseplate and the antenna would become inoperable due to damage.

Statistics: The problem has been observed on 5 of the 12 antenna systems in test. The problem was not corrected on all the fielded antennas by the end of the test.

Potential Solutions: The rear clamp assembly needs to be modified to resolve this problem. The new antennas in production need to be modified prior to fielding.

MANPRINT

Problem Number: 017

Problem Title: The operators did not learn proper site layout and set up procedures prior to going to the field with the AN/TRC-170 equipment.

MANPRINT Category: Training

Priority: B 1

Information Sources: Human Factors observation; Training Evaluation; Operator/Maintainer opinions and comments.

Description of Problem: The training course at Keesler covered site layout in a lecture only mode. The instruction was confined to antenna orientation and shelter placement. The overall layout of the field site including generators, tents, Command Post, and security was not taught at all. The students were not given any practical field experience in this area.

Implications: The system set up time is increased. The set up may include safety hazards unrecognized by the crews (i.e. generator too close to sleeping area, fuel too close to generators, etc.). The tactical security of the system may be compromised by poor site selection.

Statistics: The safety problems occurred in every initial set up during pilot test. Supervisory personnel reported the need for additional operator training in this area.

Potential Solutions: The training of operators must include practical exercises in site selection, layout, and site set up.

MANPRINT

Problem Number: 018

Problem Title: The operators (26QD6) of the AN/TRC-170 were not taught proper radiation hazard safety procedures for site selection and set up of the system.

MANPRINT Category: Training | Priority: B 1

Information Sources: Human Factors observation; Training Evaluation; Operator/Maintainer opinions and comments.

Description of Problem: The training course at Keesler covered site layout in a lecture only mode. The instruction was confined to antenna orientation and shelter placement. The radiation hazard zone in front of the antennas was not covered in terms of site selection and layout. The radiation from side and back lobes of the antenna was not discussed. The specific hazards of microwave radiation were not taught.

Implications: The crews will set up and place antennas in a manner that will pose a radiation hazard to persons outside their unit (i.e. shooting across a public road). The crews are not aware of the specific dangers of the radiation and will receive larger levels than are necessary or safe.

Statistics: All of the crews had to be instructed on the size and shape of the radiation hazard zone following pilot test.

Potential Solutions: The training of operators must include practical exercises in site selection, layout, and site set up. The radiation hazard implications should be part of the training. It is recommended that more hands on training be conducted at the school. The manuals should be modified to include specific information on radiation hazards and the areas of hazard.

MANPRINT

Problem Number: 019

Problem Title: There has not been adequate collective training accomplished with the AN/TRC-170 crews.

MANPRINT Category: Training

Priority: B 2

Information Sources: Human Factors observations; Training Evaluation; Operator/Maintainer opinions and comments; Test Directorate personnel comments.

Description of Problem: The initial field testing (Pilot Test) demonstrated the need for crew training. The crews had no collective training prior to this time.

Implications: The set up and teardown times were excessive and constituted performance OMFs. The tactical fielding of these systems could not be accomplished without collective training.

Statistics: The Pilot Test results show excessive set up and teardown times. Seventy-one percent of the operators stated that more collective training was needed; one hundred percent of the section chiefs agreed.

Potential Solutions: The unit should have regular collective training exercises and TRADOC should develop POIs and materials to support this effort. Specific ARTEP materials are needed for the AN/TRC-170 system.

MANPRINT

Problem Number: 020

Problem Title: The planning and supervisory personnel of the units receiving the new equipment were not given required new equipment orientation training.

MANPRINT Category: Training Priority: B 1

Information Sources: Human Factors observations; Training Evaluation; Supervisory personnel comments.

Description of Problem: The planning staff and operations personnel of the units responsible for the fielding of the new system (AN/TRC-170) were not given any training. The personnel responsible for network engineering are operating without adequate information and support. The personnel required to staff and operate "SYSCON" lacked AN/TRC-170 training.

Implications: The personnel who must plan networks do not have the proper training thus creating the possibility of the entire planned network failing. The supervisory personnel are not trained on site location and set up (neither are the operators) with the real possibility of safety and link engineering problems being caused by this lack of knowledge.

Statistics: We have had site location problems that delayed set up by as much as 4 hours. We have had sites set up that forced the blockage of public access roads. Supervisory and planning personnel all agreed on the necessity of this training.

Potential Solutions: The training should be developed and given to the present units. A plan should be developed to provide this training to all units receiving this system. Training should be provided for all supervisory personnel as well as planning personnel.

MANPRINT

Problem Number: 021

Problem Title: The baseplates for the truss assembly of the V2 antenna should have side holes for anchor restraint during erection process. A number of the furnished baseplates lack the holes.

MANPRINT Category: Human Factors Priority: E 1

Information Sources: Human Factors observations; Operators comments.

Description of Problem: The rear (truss) baseplate cannot use the anchor in the usual manner during the erection/teardown process. There needs to be a way to keep the anchor cable out of the way during the procedures. The anchor cable is put through a hole in the side of the baseplate to protect the cable and to keep the cable out of the way; however some of the rear baseplates do not have the hole.

Implications: The lack of a means to control the anchor cable could lead to damage of the installed anchor and slow the antenna erection and/or cause the anchor to fail after erection. Given that the hole is missing suggests quality control problems and suggests the need for better acceptance inspection by the Army.

Statistics: The problem has been identified in 4 rear baseplates, forty percent of those delivered for testing.

Potential Solutions: The supplier should improve quality control. The Army should improve acceptance testing.

Problem Number: 022

Problem Title: The anchor system for antennas, LPA, and high wind lack a means to anchor when the terrain is rock.

MANPRINT Category: Human Factors	Priority:

This problem has been combined with problems number 007 and 008 into a single problem concerned with anchors.

Problem Number: 023

Problem Title: The loading/unloading procedures for the low profile pallet are unsafe for crew personnel.

MANPRINT Category: Safety

Priority: E 4

Information Sources: MIL-STD-1472C paragraphs 4.4g and 4.8; Human Factors observation; AR 385-16 System Safety Engineering and Management.

Description of Problem: The loading/unloading procedures for the low profile pallet require the crew members to assume unsafe positions. This is particularly true when removing the canvas cover and retrieving the accessary kit.

Implications: The crews will be subject to potential short term injuries such as back strain, muscle strain, contusions, abrasions, and broken bones. The long term effects include stress related illness and reduction in retention of these personnel. The AN/TRC-170(V2) may suffer Operational Mission Failure due to this problem.

Statistics: Initially the minor accident rate was high for the V2 crews. The crews made many fatigue related mistakes and morale was low. The operators (26QD6) were interviewed and the average crew size recommended for the V2 system was four persons with some recommendations of up to six person crews. The data collection personnel agreed with the operator manning recommendations.

Potential Solutions: The canvas cover over the low profile pallet could be provided with a drawstring arrangement so that personnel would not have to climb the side of the truck. The load on the low profile pallet should be redistributed to facilitate loading/unloading and consideration given to moving some of the load to the shelter.

MANPRINT

Problem Number: 024

Problem Title: The mobilizer (M720) used for transporting the AN/TRC-170(V2) system is not adequate for the task and a different system for movement is needed.

MANPRINT Category: Safety | Priority: A 1

Information Sources: MIL-STD-1472C paragraph 5.13.1; Human Factors observation; AR 750-10 Modification of Material and Issuing Safety of Use Messages.

Description of Problem: The AN/TRC-170(V2) system must be able to be moved into off road area for site set up. The present Mobilizer (M720) has less than a one foot road clearance, which is not adequate for the mission. The shelter with equipment is reported to have a gross weight of 5170 pounds and the capacity of the mobilizer is 6000 pounds. The shelter will be used to transport other equipment in a normal tactical environment and thus will be loaded at or over capacity during off road travel. The use of any vehicle at maximum load capacity in rough terrain is not advisable.

Implications: The rate of break down of the mobilizers will be unacceptable. The potential for accidents resulting in system loss are increased.

Statistics: There are six mobilizers (M720) being used in the test; four of them have been deadlined due to weight related problems (sheared off lug posts). Five of the six have some related damage. Each tire used is restricted to an 1800 pound load limit. The weight on the roadside wheels is (2075 front and 2255 rear) over the safety limits with no cargo. The gross weight of the authorized load was 7470 pounds, an overload of 220 pounds. The wheels were weighted with tactical cargo (roadside 2290 front and 2430 rear) and the overall weight (8620 lbs) exceeded safety standards.

Potential Solutions: The system should be mounted upon a truck for usual non tactical employments of the system. The use of the mobilizer should be restricted to situations requiring air mobility. The system should not continue to use the (M720) mobilizer unless heavy duty wheels are used and cargo restrictions are carefully followed by the system user.

Problem Number: 025

Problem Title: The pins used on the AN/TRC-170(V2 & V3) antennas are difficult to use and slow down the set up/teardown process.

MANPRINT Category: Human Factors

Priority: C 1

Information Sources: Human Factors observation; Operator opinion and comments.

Description of Problem: The pins are used to hold the antennas together and to secure antenna parts to the low profile pallet. The pins fit very tightly and are very difficult to install and remove. The pins have been damaged by attempts to install/remove them using improper methods and means.

Implications: The problem with the pins slows down the erection/teardown process. There are not replacement pins with the unit so that the loss through damage could make the set up either dangerous or impossible.

Statistics: Every team has had some pin damage. The replacement of pins has been logistically difficult. Forty percent of the operators suggested a rubber mallet as an addition for supplied tools.

Potential Solutions: The pins should be treated with an approved lubricant facilitate insertion. The holes receiving the pins should be flanged to help insertion/removal. The crews should be provided with training in proper care (corrosion control) of the pins and provided with appropriate mechanical aids for insertion and/or removal of the pins.

MANPRINT

Problem Number: 026

Problem Title: The 10kw generators used to support the AN/TRC-170(V3) system cannot be changed without shutting down the radio transmission.

MANPRINT Category: Human Factors Priority: A

Information Sources: Human Factors observation; Operator and maintainer opinion/comments; Test Directorate personnel comments.

Description of Problem: The 10kw generators supply power for the V3 version of the AN/TRC-170. There are two generators mounted on a single trailer with the mission of supplying continuous power for the radio system. The power cannot be switched from one generator to the other without a power interruption because of the lack of a proper power switching system for the generators.

Implications: The interruption caused by the switching of generators is 10 to 15 minutes. The mission of the unit will therefore be interrupted approximately every 6 hours for 10 to 15 minutes. Any interruption could be considered an OMF.

Statistics: This has occurred on every V3 system since the start of testing.

Potential Solutions: Provide the 10kw generators with the proper switching capability.

MANPRINT

Problem Number: 027

Problem Title: The 10kw generators used to support the AN/TRC-170(V3) system do not have the appropriate built-in capability to adjust for power load variations.

MANPRINT Category: Human Factors

Priority: B 1

Information Sources: Human Factors observation; Operator and maintainer opinion/comments; Test Directorate personnel comments.

Description of Problem: The 10kw generators supply power for the V3 version of the AN/TRC-170. There are two generators mounted on a single trailer with the mission of supplying continuous power for the radio system. The generators are not equipped with a device which would adjust for increased power demands. The operator must remember to readjust the generator when and if power output is increased (i.e. HPA is turned on).

Implications: The failure to adjust the generator for increased power usage can result in the generator failing causing an OMF.

Statistics: This occurred on several V3 systems during the conduct of the test.

Potential Solutions: Provide the 10kw generators with the proper load compensation capabilities to assure continuous level power output. It should be noted that the generator is GFE and does not have the requested capability as a standard feature.

MANPRINT

Problem Number: 028

Problem Title: The operators lack training on troubleshooting system end-to-end problems.

MANPRINT Category: Training

Priority: B 2

Information Sources: Human Factors observations; Training Evaluation; Operator/Maintainer comments.

Description of Problem: The operators have difficulty determining the nature and location of problems related to system troubleshooting. The subject was given minimal coverage at Keesler training. The NETT did not cover this area. The operators believe that if their van is "green" they have no problem even when they are not communicating.

Implications: The systems may be operational, but unless the shot can be brought-in (end-to-end communication) there is no communication (an OMF).

Statistics: This happened numerous times in the test. Supervisory personnel report a real requirement for this training.

Potential Solutions: The training course should provide more hands on training on system problems. The manuals should provide detailed fault isolation methodologies for determination of probable reasons for communication failures.

This problem was combined by group majority with problem 028.

Problem Number: 029

Problem Title: The operators/maintainers lack training on the interaction of COMSEC equipment with AN/TRC-170 operation.

MANPRINT Category: Training

Priority:

Information Sources: Human Factors observation; Training Evaluation; Operator/Maintainer comments.

Description of Problem: The operators and maintainers have received no training on the interaction of the COMSEC gear used in the AN/TRC-170 with the other electronics in the system.

Implications: The system has been down because operators did not know how to interrupt symptoms that indicated a problem with the fill on a COMSEC device. The lack of training has caused Operational Mission Failures.

Statistics: Thirty-seven percent of the operators report problems related to COMSEC gear interaction with AN/TRC-170. Supervisory personnel report that lack of training on the effects of COMSEC gear is a major time-comsuming problem. Fifty percent of the V2 operators reported COMSEC problems.

Potential Solutions: The Kessler training should include the COMSEC interaction with the system. The operators should be made aware that the lockup of the orderwire bridge is most likely due to the status of the VINCINT device.

MANPRINT

Problem Number: 030

Problem Title: The number of maintainers allocated for system support is inadequate.

MANPRINT Category: Manpower

Priority: B 1

Information Sources: Human Factors observations; Operators and maintainers opinions/comments; Test Directorate personnel comments.

Description of Problem: The AN/TRC-170 system when employed will be geographically dispersed at least as much as it has been during the test. The ability of the maintainers while good, has not been sufficient to provide 24 hour-a-day coverage with present personnel. The test used three times the number maintenance personnel as were authorized in the TO&E.

Implications: The system will have significant down time due to lack of maintainer availability. The system will not be able to meet its tactical mission requirements.

Statistics: Significant administrative delays were recorded for maintenance during the test. The test used three maintainers, but only one is actually authorized by the TO&E.

Potential Solutions: The allocation of maintenance personnel (29M) for this system should be increased to one maintainer for each fielded system. The maintainer could also be used as an additional operator and as crew to augment set up and tear down tasking.

MANPRINT

Problem Number: 031

Problem Title: The waveguide attachment to the antenna and the shelter needs redesign.

MANPRINT Category: Human Factors

Priority: B 2

Information Sources: Human Factors observations; Operator comments.

Description of Problem: The waveguide attachment to the antenna and the shelter needs redesign. The alignment pins are not secure. The o-ring used as a moisture seal is not fixed and falls out very easily. The latch is manually difficult to secure or release. The latch problem is made worse by protective gloves and, it is assumed, by arctic gloves.

Implications: The system could become unavailable due to the waveguide attachment problem. The failure of the moisture seal could cause excessive reflected power and/or overheating of the waveguides.

Statistics: Currently ten waveguides have damaged pins. The waveguide is the most frequently cited interface problem by the AN/TRC-170 operators.

Potential Solutions: The waveguide attachment system should be reviewed with the possibility of redesign considered. There should be consideration given to making the attachment task a two person task.

Problem Number: 032

Problem Title: The AN/TRC-170 shelter floors do not have nonskid surfaces or antistatic protection.

MANPRINT Category: Safety

Priority: C 1

Information Sources: Human Factors observations; MIL-STD-1472C paragraph 4.8; AR 385-10 Army Safety Program.

Description of Problem: The shelters used to house the AN/TRC-170 systems are S-280 (V2) and S-250 (V3). The shelters are painted metal including the floors. Metal floors in a tactical environment are dangerous unless surfaced with nonskid material. The electronic components in the shelters are subject to damage by static discharge. The floor protection needs to include antistatic capability.

Implications: The probability of minor injury to personnel is increased. There is also a possibility of equipment damage due to operator or maintainer falling and/or dropping gear. There is also possibility of static damage to system components.

Statistics: No problems occurred during the test

Potential Solutions: The shelters must be equipped with nonskid, antistatic floors.

MANPRINT

Problem Number: 033

Problem Title: The operators were not adequately trained in the use of the pocket transit.

MANPRINT Category: Training

Priority: C 2

Information Sources: Human Factors observations; Training Evaluation; Operator opinion/comments.

Description of Problem: The operators were reported to be trained in the use of the compass known as the "Pocket Transit". This compass is not the one used as a common task compass. The operators initially had difficulty using the Pocket transit for site layout. The operators have used an informal on-the-job learning to get to a point where the pocket transit could be consistently used. The test environment is the only reason this occurred so fast.

Implications: The system operators will make errors of antenna alignment and site set up. The system will take longer to become operational.

Statistics: Operators were observed making errors with the pocket transit and corrected by test personnel.

Potential Solutions: The training in the use of the compass should part of the training at Keesler.

Problem Number: 034

Problem Title: The access for maintenance in the V3 does not meet military standards.

MANPRINT Category: Human Factors Priority: C 2

Information Sources: MIL-STD-1472C paragraphs 5.9.3 - 5.9.4; Human Factors observations; Maintainer comments.

Description of Problem: The space within the shelter is restricted. The hand and arm room behind the panels is so limited that average size persons have difficulty accessing fasteners for component removal. The hand strength required to remove fasteners is in excess of usual hand strength. Components that weigh enough to require two person lifts are located so access is limited to one person.

Implications: The overall maintainability of the system is in question. The space arrangement is such that personnel size restrictions may be necessary.

Statistics: Eighty-three percent of the operators stated the work/maintenance area in the V3 was too small.

Potential Solutions: The arrangement of components within the V3 shelter should be reviewed.

MANPRINT

Problem Number: 035

Problem Title: The weight distribution and balance of the V2 shelter is a problem.

MANPRINT Category: Human Factors | Priority: A 1

Information Sources: Human Factors observation; Air Force testing of the AN/TRC-170(V2); AR 385-10 Army Safety Program.

Description of Problem: The electronics and radio equipment of the AN/TRC-170(V2) system within the shelter is all located upon the roadside. The Air Force has determined that the shelter is not stable on over a twenty degree side tilt. The shelters weight and balance are the problem.

Implications: The system has limits on the terrain and roads it can be sent across. The accident potential is higher than necessary. The system is restricted as to prime movers that can be used.

Statistics: The selection of sites for the test was adversely influenced by the roadability restrictions of the V2 system. No accidents occurred because of the weight distribution due to excessive care exercised during the test.

Potential Solutions: The internal arrangement of equipment for the V2 system should be reviewed and corrected.

Problem Number: 036

Problem Title: The noise levels in the AN/TRC-170 shelters require that hearing protection be worn by anyone in the shelter area for brief periods of time.

MANPOWER Category: Safety

Priority: A 1

Information Sources: Measures of sound level taken by HF personnel MIL-STD-1472B paragraphs 5.8.3.1 - 5.8.3.4; MIL-STD-1474B Noise Limits for Army Materiel.

Description of Problem: The noise levels within the shelters exceed minimum for hearing damage, especially in the midrange of hearing 125H to 2KHertz). The overall dB(A) weighted average was in the hearing damage range for both shelters. Hearing protection is required for all persons in the shelters during shelter operation.

Implications: The operators and support personnel for the AN/TRC-170 system will suffer profound hearing loss unless adequate hearing protection is provided.

Statistical Measures were taken with shelter door open and with the door closed. The systems were in high power mode.

Shelter door open

Van	Weighted	31.5	63	125	250	500	1K	2K	4K	8K	16K	Hertz
V3	87	78	79	84	80	82	81	74	69	75	71	dB(A)
V2	87	90	80	89	79	83	87	78	72	70	71	dB(A)

Shelter door closed

Van	Weighted	31.5	63	125	250	500	1K	2K	4K	8K	16K	Hertz
V3	89	82	81	86	80	84	87	81	75	75	69	dB(A)
V2	89	90	80	89	80	87	87	78	73	71	71	dB(A)

Potential Solutions: The headset used by the operators should be replaced with the aviation style headset with hearing protection for both ears. The training and doctrine should emphasis using the ROCU whenever possible to minimize in-shelter time. Safety release should require hearing protection for all persons in either van at any time during operation of the system.

The majority of the MANPRINT scoring conference were of the opinion that there was not sufficient evidence to support this problem statement. The economic costs of replacing the V2 antenna system would be very large and was an important consideration in the deferment of this issue.

Problem Number: 037

Problem Title: The 9.5 ft. antenna for the AN/TRC-170(V2) is not adequate for tactical deployment; it is a semifixed site antenna.

MANPRINT Category: Human Factors

Priority:

Information Sources: Human Factors observations; Operator and Test Directorate personnel comments; Performance and RAM data.

Description of Problem: Army doctrine calls for the AN/TRC-170 system to be able to move every 96 hours. The 9.5 ft. antenna system for the V2 is not rugged enough to withstand this frequency of teardown/setup. The fatigue of the crew over time for numerous moves would also restrict the mobility of the system. The logistics of expendables such as the anchors would severely restrict the tactical use of the antenna. The antenna appears to be intended for semi-permanent sites with moves figured in months rather than hours.

Implications: The system will not be able to meet tactical mission requirements over time. Initial deployment will be fine but as the antenna becomes more worn and parts, supplies, and personnel less available the system will not be able to perform its mission.

MANPRINT

Problem Number: 038

Problem Title: The lack of a high frequency radio associated with each shelter will lead to Operational Mission Failures.

MANPRINT Category: Human Factors

Priority: A 1

Information Sources: Human Factors observations; Operator, data collectors, and Test Directorate opinions; Performance and RAM test data.

Description of Problem: The AN/TRC-170 system has a recognized need for a HF radio. The proposed HF radio is not available at this time for fielding with the system. The HF radio is critical to link engineering and maintenance management of the deployed AN/TRC-170 units. A substitute HF radio is imperative.

Implications: The establishment of difficult Tropo links will be either delayed or prevented without the capability of independent end-to-end communications. The management of the maintenance operation at the present manning and supply levels will be impossible. The lack of the HF radio or an appropriate substitute will lead to OMFs.

Statistics: During the test less than ten percent of the Tropo links were established without HF or FM radio assistance. The maintenance system was totally dependent upon radio communications.

Potential Solutions: The PM should select an alternate available HF radio for AN/TRC-170 and supply it with all systems until the proposed radio is available.

The majority of the MANPRINT scoring conference determined that the capability of the GFE truck was not an appropriate test consideration. The issue should not be part of the test results.

Problem Number: 039

Problem Title: The 2.5 ton truck used as a prime mover for the AN/TRC-170(V2) system is not adequate for the task and should be replaced.

MANPRINT Category: Human Factors	Priority:

MANPRINT

Problem Number: 040

Problem Title: A ladder with hand railing and center tailgate mounting is needed for truck mounted systems.

MANPRINT Category: Safety

Priority: A 1

Information Sources: MIL-STD-1472C paragraphs 5.7.7.3 & 5.12.7.2c.; MIL-H-46855B paragraph 3.2.2.3i.; Human Factors observations.

Description of Problem: Safe access is required for all systems. The mounting of AN/TRC-170 on trucks requires that suitable ladder access be provided for the systems. The ladders used during the test did not meet standards. Ladder access should be directly in front of the doors (center of the tailgate) and must have a hand rail. The ladder for access should be part of the fielded system.

Implications: The lack of safe access will led to accidents that have the potential for injury to personnel or damage to system equipment.

Statistics: No truck mounted system in the test had safe access ladders.

Potential Solutions: An appropriate ladder and ladder mounting should be provided with all AN/TRC-170 systems fielded.

The majority of the MANPRINT scoring conference voted to eliminate this problem due to the fact that no environmental testing was conducted to support or eliminate this issue during this test. There has been an administrative decision made that ECUs are not required for the AN/TRC-170 system.

Problem Number: 041

Problem Title: The AN/TRC-170 shelters should each be equipped with an Environmental Control Unit (ECU) that both heats and cools the shelter.

MANPRINT Category: Human Factors	Priority:

Information Sources: MIL-STD-1472C paragraphs 5.8.1.1 - 5.8.1.8; Operator and Data Collection comments; Human Factors observations.

This problem becomes a non issue if the prior problem (#041) is considere not to be an issue. No consideration will be given to this issue unless the issue of an ECU is considered.

Problem Number: 042

Problem Title: The 10kw generator set fielded to support the AN/TRC-170(V3) should be upgraded to at least a 15kw generator system.

MANPRINT Category: Human Factors	Priority:

MANPRINT

Problem Number: 043

Problem Title: The waveguides for the V2 system had a high rate of damage during the test. A method or means is needed in order to minimize damage to the waveguides.

MANPRINT Category: Human Factors Priority: B 1

Information Sources: Human Factors observations.

Description of Problem: The test demonstrated a problem of waveguide damage. The V3 QRA has the waveguides in a metal container that is removable from the antenna. The V2 system uses the same containers but they are fixed on the pallet. The damage to the waveguides was often during the time that they were lying upon the ground during setup/teardown. The waveguides should/could be placed in the metal containers thus affording them more protection during this time period. The ability to remove the containers from the pallet would facilitate the use of the containers.

Implications: Waveguide will continue to be damaged at a costly rate. Damaged waveguide will reduce the efficiency of the Tropo communications. The logistic problems will be increased due to waveguide replacement requirements.

Statistics: The test had one third of its waveguides unusable at one point in the test. Waveguide had to be borrowed to continue testing due to a shortage of waveguide.

Potential Solutions: Operator training needs to be augmented on the subject of handing and care of system waveguides. The unit supervisors should also promote the special handling of the waveguides. The containers for the waveguide are now mounted upon the pallet. The containers should be made removable and the operators trained to use them for protection of the waveguides.

MANPRINT

Problem Number: 044

Problem Title: The AN/TRC-170 shelters need built in seating to be provided for operators.

MANPRINT Category: Safety

Priority: C 3

Information Sources: Human Factors observations.

Description of Problem: The operators will sit during extended time periods in the shelters. The lack of provided seating means they will use whatever is available (i.e. water coolers, Pionjar box, folding chairs, etc.). The use of inappropriate items for seating increases accident possibilities. The shelters will be used for extended periods of time and reduction of loose unauthorized items should be encouraged.

Implications: The operators will use what is available if seating is not provided. The potential for accidents causing injury to operators and/or damage to equipment is increased.

Statistics: Since appropriate seating was unavailable all operators in the test used unauthorized seating.

Potential Solutions: A fold down or fixed seat should be made a part of all shelters.

The majority of the MANPRINT scoring conference voted to combine this problem with problem 012. The overall issue is safe methods and means of climbing and reaching.

Problem Number: 045

Problem Title: The rear truss of the 9.5 ft. antenna should be modified to provide safe hand/foot holds for climbing.

MANPRINT Category: Safety	Priority:

APPENDIX B

INTERVIEW DATA

Operator Interview Data

All reference to questions in this interview give the question number preceeded by the letter"O".

Respondent Demographics:

Rank E-3 = 25, E-4 = 6, E-5 = 4 Avg. Age = 21.0 MOS 260 D6 = 35

Average Time in MOS = 1.4 years

Average Years of Military Service = 2.3

Average Years of Civilian Education = 12.2

Average months of Military Education = 7.0

Average No. of military schools attended = 2

Respondents = 35

V2 = 19; V3 = 11; Section Chiefs (SC) = 5

Have you experienced any difficulties with the set-up or operation of the following items on the AN/TRC-170?

	Percentage of Yes responses by operators Response groups	Total	V2	V3	SC
1.	RF Amplifier	9	5	18	0
2.	Control Logic Assembly	3	5	0	0
3.	Control Logic Assembly Circuit Cards.	3	5	0	0
4.	High Voltage Power Supply	31	26	36	40
5.	Fast Interrupt (FAINT) Assembly	0	0	0	0
6.	Inverters	0	0	0	0
7.	RF Protect and Metering	3	5	0	0
8.	Klystron	34	21	45	60
9.	Amplifier Up-converter Assembly	3	5	0	0
10.	Downconverter Assembly	6	5	9	0
11.	Dual RF Synthesizer	6	0	18	0
12.	Tropo Modem Modulator	20	16	36	0
13.	Tropo Modem Demodulator	14	16	18	0
14.	TED 1 and 2	37	21	55	60
15.	COMSEC gear in general	37	32	45	40
16.	Low Voltage Power Supply	17	11	27	20
17.	Baseband Patch Panel	17	32	0	0
18.	Loop Group Multiplexer (LGM-1)	9	5	18	0
19.	Group Modem	11	11	9	20
20.	Trunk Group Multiplexer	0	0	0	0
21.	LGM-2/LSCDM	3	0	9	0
22.	Ac to Ac Converter	14	21	0	20
23.	V2 mobilizer	43	53	9	80
24.	Alarm Monitor	3	0	9	0
25.	Orderwire Control Unit	31	32	27	20
26.	IF Test Panel	3	0	9	0
27.	Heater Assembly	34	26	45	40
28.	Analog Voice Orderwire Unit	9	11	0	20
29.	Noise Source	0	0	0	0
30.	Flushing Fan	0	0	0	0
31.	Remote Orderwire Control Unit (ROCU).	34	21	55	40
32.	LED Matrix Circuit card assembly	6	5	9	0
33.	Heat Sensor Warning Switch	0	0	0	0
34.	Centrifugal Fan	0	0	0	0
35.	Tube axial Fans (specify)	0	0	0	0
36.	Vane axial Fan	0	0	0	0

(TR 3.1.1.1.10)

Comments on next page

Comments from operators concerning items 1 to 36.

Supervisors (section chiefs) N = 5

Question Number	Comments	number of comments
Q04	High Voltage power supply (overvoltage) =	1
Q08	Klystron (will not take power surges) =	3
Q09	Switch jammed =	1
Q14	TEDS a problem (training, connecting pins) =	3
Q16	Low Voltage power supply had a bad panel =	1
Q23	Mobilizers (wheel) =	3
Q25	Orderwire bridge locks up =	2
Q27	Heaters don't heat =	2
Q28	AVOU keeps giving false alarms =	1
Q31	ROCU (does not match van reading) =	1

V2 operators N = 19

Question Number	Comments	number of comments
Q4	High Voltage power supply (overvoltage, shuts off by its self) =	5
Q8	Klystron (will not take power surges, arcing) =	4
Q9	Fault light bad =	1
Q10	Knobs stripped =	1
Q12	Bad cards A14 comes on but no problem =	2
Q14	TEDS (training, connecting pins, loading) =	3
Q15	COMSEC (more training needed, KY-68s a problem) =	4
Q16	Fault light kept coming on with no fault =	2
Q17	Loose wire (plug would not work) =	1
Q18	LGM-1 bad for most of the test =	1
Q19	Equipment damaged due to operator error =	1
Q22	Had to keep resetting and must shut down to do it =	3
Q23	Mobilizers (wheels, lug nuts, & not rugged enough) =	7

V3 Operators N = 11

Question Number	Comments	number of comments
Q04	Dummy load switch bad (10 days to fix)	1
Q08	Klystron power surges; overvoltage =	5
Q11	Dual RF would not tune to selected frequencies =	2
Q12	Tropo modem fault light stayed on; bad cable; =	5
Q14	Training needed; Not reliable; difficult to load;	6
Q15	Need more COMSEC training; bad connectors on the KY-13s; orderwire locks up;	4
Q16	Cards bad =	1
Q18	LGM-1 card bad most of test =	1
Q27	Heater does not work =	2
Q31	ROCU bridge locked up; showed faults when there were none; could not talk to distant end; headset did not work =	5
Q32	LED stayed on all the time during test =	1

37. Were there any situations during equipment diagnosis, repair or checkout that BITE was used but it was not designed to detect the problem encountered?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	31	21	45	40

Comments:
Section Chiefs (SC) There was no indicator for orderwire lockups; Fault lights indicated wrong problem on two occations.

V2 operators Fault lights did not detect dented waveguide; Loose patch and patch plug wire loose were not detected; problem at distant end but fault light on in our van.

V3 operators Problem at distant end but fault light on in our van; problem in the van but no fault light; power converter off 50kh with no fault light; HPA fault lights did not function.
(TR 3.1.1.1.15e)

38. Were there any situations during equipment diagnosis or checkout when BITE was not used but it should have been?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	6	0	9	20

Comments:
One V3 operator reported that sometimes faults were so easy to detect that BITE was not needed. Section Chiefs reported only one instance of BITE not being used when it should have been.
(TR 3.1.1.1.15f)

39. Were adequate alternative diagnostic procedures available when BITE/TMDE was not?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	66	74	64	40

Comments:
All respondants (N =9) reported flowcharts hard to use.
(TR 3.1.1.1.15f)

40. Overall, were equipment failures easy to recognize during configuration set-up and operation?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	94	95	91	100

Comments:
One operator reported transmit/receive synthezier was off in field but when but but when brought in it was ok
(TR 3.1.1.1.16)

Do you believe that with the training and experience you have had to date that you are SQT-qualified on the following operations-related tasks?

Percentage of Yes responses by Operators Response groups	Total	V2	V3
41. Configuring the system with assignment sheets...	100	100	100
42. Calibrating/Adjusting the Shelter Components....	97	100	100
43. Recognizing faults during configuration set-up..	100	100	100
44. Fault diagnosis using MITE.....	100	100	100
45. Fault isolation using the flow charts.....	97	100	91
46. Fault diagnosis without BITE.....	94	100	91
47. Conducting Performance Test Checks.....	97	95	100
48. Performance PMCS.....	100	100	100
49. Removing/Replacing Shelter Components.....	91	100	91
50. Site Layout.....	100	100	100
51. 9.5 ft. Antenna Assembly.....	91	100	73
52. 9.5 ft. Antenna Disassembly.....	91	100	73
53. QRA Antenna Assembly.....	77	63	100
54. QRA Antenna Assembly.....	77	63	100
55. Antenna Adjustment and alignment.....	100	100	100
56. LPA Assembly/Erection.....	100	100	100

Comments. One section chief and one V2 operator reported concerns about troubleshooting without fault lights (Question 46). Section chief also reported that more extensive PMCS should be required (Question 48).

Can any three persons who can hold the 26Q MOS and proper skill identifier perform the following tasks? (The issue here is size and physical strength)

	Percentage of Yes responses by operators			
	Response groups	Total	V2	V3	SC
57.	Erection of the LPA.....	17	26	0	20
58.	Disassemble the LPA.....	34	47	9	40
59.	Unload the low profile pallet.....	57	63	64	20
60.	Erect the 9 1/2 ft. antenna.....	43	53	36	40
61.	Disassemble the 9 1/2 ft. antenna.....	51	63	36	40
62.	Maneuver the V2 shelter into position. (Assuming use of the mobilizer alone)	6	5	9	0
63.	Maneuver the QRA into position.....	71	68	91	40
64.	Install a complete set of ground stakes (Assumes 22 stakes and a time limit)	57	63	55	40
65.	Get TRC-170 V2 operational in 5 hours.	40	42	45	20

Comments. Two Section Chiefs commented that the size of the crew is important, that small persons could not accomplish the V2 tasks. One SC stated that LPA needed redesign to be handled by three people.

V2 Operators
Q57-58 Three persons on the LPA is dangerous = 3
Q59 can not unload without physical risk = 3
Q60-61 need a ladder for this task = 1
Q64 depends on how hard the ground is on site = 3
Q65 Antenna assembly and anchors take too long = 3

V3 Operators
Q57-58 Three persons on the LPA is dangerous = 4
Q64 depends on how hard the ground is on site = 5
Q65 Antenna assembly and anchors take too long = 2
(TR 3.1.4.1.1)

66. Will the supply allocations and procedures for AN/TRC-170 be compatible with the existing Army Supply System?

Percentage of yes responses by operators				
Response groups	Total	V2	V3	SC
	34	32	36	40

Comments. Eight respondents reported system is not yet compatible, but will be when the supply system is updated. Four respondents reported the need for base plates and antenna pins. Two V2 and three V3 operators reported a need for additional anchors and reported Pionjar fuel as a problem.
(TR 3.1.2.1.2)

67. Was the maintenance authorizations and organization adequate?

Percentage of Yes responses by operators Response groups	Total	V2	V3	SC
	29	42	9	20

Comments. Seventeen respondents reported the need for more maintenance personnel. Two operators stated that more maintenance tasks should be assigned to operators. Two operators reported the need for more complete risk kits.
(TR 3.1.2.1.3)

68. Is the current assignment strategy of operations and maintenance personnel adequate for effective mission performance?

Percentage of yes responses by operators Response groups	Total	V2	V3	SC
	11	16	9	0

Comments. Twenty-six respondents reported that at least one maintainer per two systems required and minimum of four person crews on both V2 and V3.
(TR 3.1.2.1.3)

69. Are common and special tools supplied with AN/TRC-170 equipment adequate for effective mission performance?

Percentage of yes responses by operators Response groups	Total	V2	V3	SC
	71	63	91	60

Comments. Tools needed:

Mallet	= 5
File	= 1
Punch for pin removal	= 3
Hammer	= 1
Tape measure	= 1
Cresent wrench	= 2
Ladder	= 1
Larger diameter bit for the Pionjar	= 1
Wire cutters (large size)	= 1
Generator cable wrench	= 2

(TR 3.1.3.1.2)

70. Is TMDE & Calibration equipment for AN/TRC-170 adequate?

Percentage of Yes responses by operators Response groups	Total	V2	V3	SC
	63	74	55	40

Comments. Operators are unaware of any TMDE or calibration equipment for this system. (TR 3.1.3.1.3)

71. Are you able to perform all the maintenance tasks assigned to operators for TRC-170?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	97	100	100	80

Comments. The operators should be given more maintenance tasks. This statement made by six respondents. (TR 3.1.3.1.5)

72. Are there any changes in equipment design or location needed to change peripherals or install spares?

Percentage of yes responses by operators

Response groups	Total	V2	V3	SC
	29	26	27	40

Comments. Four operators reported the V3 van was too small for remove and repair tasks, the Klystron was cited as a big problem. Four respondents felt spares should be carried by each unit in the field. Two operators felt better storage in shelters was needed for tools and spares. (TR 3.1.3.1.10)

73. Did the crew size used in the test provide enough people during tactical situations to accomplish all other tasks required to operate and maintain the AN/TRC-170 V2 and/or the V3?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	26	32	27	0

Comments. Eighteen respondents reported that tactical situation action such as perimeter guards is not possible with current manning. (TR 3.1.4.1.1)

74. In your opinion are the anchors (duckbills) used for the 9.5 ft. antenna and the LFA an effective system for the AN/TRC-170 in tactical circumstances?

Percentage of Yes responses by operators				
Response groups	Total	V2	V3	SC
	26	32	27	0

Comments. Ten respondents commented that in hard ground the anchors take an excessive amount of time to install. Fourteen respondents reported that a variety of anchors are needed (rock; arrowhead; smaller) and more spare anchors are needed. Three operators indicated the need for anchors that could be extracted after use. One operator suggested that the baseplates be modified so hammer-driven stakes could be used if duckbills were not available. (TR MANPRINT)

75-80. Are the operators able to perform the following tasks well enough to be able to pass an SQT?

Percentage of Yes responses by operators				
Responses	Total	V2	V3	SC
75. Azimuth determination.....	97	100	100	80
76. Properly position antenna on the site..	97	95	100	100
77. Adjust Klystron.....	100	100	100	100
78. Generator operation/PMCS.....	97	95	100	100
79. Tactical set up of a tropo-radio site..	91	89	100	80
80. Understand/Use Crew Assignment Sheet...	100	100	100	100

Comments.

Q75	operators not trained on the compass used in AN/TRC-170	= 1
Q78	paralleling generators still a problem	= 1
Q80	Problem with the creation of the cut sheets	= 1

(TR 3.1.4.1.2)

81. In your opinion should the location of items on the low profile pallet or in the shelter be changed? For example move the accessory kit to the shelter or truck?

Percentage of Yes responses by operators				
Response groups	Total	V2	V3	SC
	51	63	21	40

Comments. The following items should be stored/transported in the shelter:

Accessory kit	= 10
Stow bags (security of contents)	= 4
ROCU should be stowed in shelter	= 5
Put stow bags on open end of the pallet	= 1
Provide storage/carrying space for TA-50	= 1
Change position of Pionjar in V3 (rotate 90 d)	= 1

(TR MANPRINT)

82. Have you observed any situations where the operator or maintainer had to reach or climb in a manner that was not safe? (For example, they should have had a ladder.)

Percentage of Yes responses by operators				
Response groups	Total	V2	V3	SC
	63	63	64	60

Comments. Twenty-four respondents reported needing a ladder. (TR MANPRINT)

83. Are the AN/TRC-170 V2 and V3 shelters, equipment, antennas, and support equipment rugged enough to withstand continued field use?

Percentage of Yes responses by operators				
Response groups	Total	V2	V3	SC
	66	63	73	60

Comments.

Section Chiefs
- Antenna metal not strong enough (hooks, clips, baseplates broken) = 1
- Mobilizer = 1

V2 Operators
- mobilizer = 7
- waveguides = 2
- Antenna pins = 2
- Hoist rope bends too much = 1
- LPA rope (frags and leaves splinters) = 1
- HF radio, one we have is junk = 1

V3 Operators
- Waveguides (flexibility) = 2
- Orderwire headset - not adequate = 1
- Mobilizer = 1
- 2&1/2 ton truck not rugged enough = 1

(TR 3.1.7.1.1)

84. Did you have any problems reaching any of the sites used in the test due to lack of mobility of the AN/TRC-170 equipment?

Percentages of Yes responses by operators				
Response groups	Total	V2	V3	SC
	26	11	45	40

Comments. Ten respondents reported the mobilizer a problem. The decision not to use the Scott Peak site was reported due to the mobilizer. (TR 3.1.7.1.1)

In your opinion, how many persons are required to perform the following setup and teardown tasks safely and efficiently on the AN/TRC-170 V2?

Average of the responses by operators

Response groups	Total	V2	V3	SC
85. LPA erection.....	4.1	4.2	4.1	4.2
86. LPA lowering.....	3.9	3.8	4.0	3.8
87. 9 & 1/2 ft. antenna erection....	3.9	3.8	3.8	4.4
88. 9 & 1/2 ft. antenna lowering....	3.9	3.8	3.8	4.2
89. Load/unload low profile pallet..	3.6	3.4	3.8	4.2
90. Position V2 mobilizer/shelter...	5.5	5.7	5.0	6.0
91. Set anchors with Pionjar.....	2.9	2.7	2.8	3.6

Comments

Q85-86 if LPA baseplate were hinged would only need three people = 1

Q91 depends on how hard the ground is on the site = 1

(TR 3.1.7.1.9)

In your opinion, how many persons are required to perform the following setup and teardown tasks safely and efficiently on the AN/TRC-170 V3?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
92. LPA erection.....	4.1	4.2	4.1	4.2
93. LPA lowering.....	3.9	3.9	4.0	3.8
94. QRA assembly.....	3.0	2.9	2.9	3.6
95. QRA disassembly.....	3.0	2.9	2.9	3.4
96. Position/set up 10kw generators.	2.7	2.8	2.5	3.0
97. Position QRA trailer.....	2.7	2.8	2.5	2.8
98. Set anchors with Pionjar.....	2.7	2.6	2.5	3.4

comments

Q92-93 if LPA baseplate were hinged would only need three people = 1

(TR 3.1.7.1.9)

99. Did you experience any problems during set-up and teardown of the AN/TRC-170 V2?

Percentage of Yes responses by operators				
Response groups	Total	V2	V3	SC
	49	58	27	60

Comments

Pionjar driver stuck while setting anchors	= 3
Antenna pins stuck and/or broken	= 5
Wench cable frayed and tangled in hoist	= 2
LPA cable frayed	= 3
Need different anchor (rock, smaller, etc.)	= 1
Clamp on rear truss assembly	= 3
Feedhorn in/out of storage assembly	= 1
Waveguide connections	= 1
V2 antenna hub pin alignment	= 2
Antenna pin holes full of paint	= 2
Anchors	= 2
Antenna not rugged enough	= 2

(TR 3.1.7.1.9)

100. Did you observe any problems during set-up and teardown of the AN/TRC-170 V3?

Percentage of Yes responses by operators				
Response groups	Total	V2	V3	SC
	14	5	27	20

Comments

Need additional crew to do setup and teardown properly	= 1
Waveguide damaged by LPA mast falling upon it	= 2

(TR 3.1.7.1.9)

During the test have you noticed any differences between the AN/TRC-170 and the equipment it is supposed to replace in terms of ease of operation, ease of set-up/teardown, ease of maintenance (diagnosis, calibration, removal and replacement)?

Percentage of Yes responses by operators Response groups	Total	V2	V3	SC
101. Ease of operation.....	86	89	82	80
102. Ease of Set-up.....	74	63	91	80
103. Ease of teardown.....	69	58	91	60
104. Ease of diagnosis for maintenance...	63	63	64	60
105. Ease of calibration.....	69	63	91	40
106. Ease of component removal.....	69	68	82	40
107. Ease of component repair.....	57	68	55	20
108. Ease of configuration set-up.....	83	84	82	80
109. Safety.....	57	63	64	20
110. Reliability.....	69	74	73	40

Comments	
Q101 AN/TRC-170 is easier to operate	= 7
Q102 Much easier to set up	= 6
Q102 Antenna more difficult to set up	= 4
Q103 easier to tear down	= 5
Q109 it is a safier system (except mobilizer)	= 5
Q109 crew size makes system unsafe	= 2
Q110 AN/TRC=170 is more reliable	= 6

(TR 3.1.9.1.1)

111. In your opinion are there any aspects of environment such as illumination, noise, ventilation, temperature, vibration, and climate that pose a potential problem for AN/TRC-170 operators?

Percentage of Yes responses by operators				
Response groups	Total	V2	V3	SC
	57	58	45	80

Comments

Noise level in the van = 19
Temperature (in LOS mode no heat in the van) = 14
(also very hot in sun with no ECU)
(TR MANPRINT)

112. Were personnel able to effectively perform configuration set-up functions in MOPP 4 gear? (HF)

Percentage of Yes responses by operators				
Response groups	Total	V2	V3	SC
	60	37	91	80

Comments

Night setup a problem in MOPP gear = 3
Fatigue a big problem = 2
Gloves reduce sensitivity, make configuration hard = 3
Time increse is great = 7

(TR MANPRINT)

113. Are the diagnostic outputs of the AN/TRC-170 equipment easy to use?

Percentage of Yes responses by operators				
Response groups	Total	V2	V3	SC
	94	95	91	100

(TR 3.1.1.1.15e)

114. In your opinion, is the AN/TRC-170 BITE effective for system operations and maintenance?

Percentage of Yes responses by operators				
Response groups	Total	V2	V3	SC
	100	100	100	100

Comment

System sometimes was a little slow in showing up some problems
(TR 3.1.1.1.15e)

115. In your opinion, would the AN/TRC-170 be effective (if fielded in its present form) for aiding signal/ communications missions?

Percentage of Yes responses by operators				
Response groups	Total	V2	V3	SC
	91	89	100	80

Comments

Improvements are needed	= 1
Antenna for V2 needs redesign	= 4
Question survivability in humid/wet areas	= 1
Need more spares with each van	= 1

(TR MANPRINT)

116. Is the overall operation of the AN/TRC-170 equipment effective?

Percentage of Yes responses by operators				
Response groups	Total	V2	V3	SC
	100	100	100	100

(TR 3.1.9.1.1)

117. In your opinion could personnel effectively perform maintenance functions in MOPP 2 gear?

Percentage of Yes responses by operators Response groups	Total	V2	V3	SC
	91	89	100	80

Comments

One response as long as mopp gear is serviceable
(TR MANPRINT)

118. In your opinion could personnel effectively perform maintenance functions in MOPP 4 gear?

Percentage of Yes responses by operators Response groups	Total	V2	V3	SC
	37	21	64	40

Comments

Mask (vision) would be major problem	= 1
Gloves (finger sensitivity) a major problem	= 3
Repair would take alot longer	= 7

(TR MANPRINT)

119. Have you observed any physical interface problems with AN/TRC-170? (i.e. cables, waveguide, etc.)

Percentage of Yes responses by operators Response groups	Total	V2	V3	SC
	54	74	36	20

Comments

Waveguide connections a major problem	= 15
Power cable hookups	= 1

(TR 3.1.8.1.6)

SAFETY

Have you or others observed potential or actual safety hazards that could result in shock, burns, falls, cuts, bruises, explosions, entanglements in moving parts, strains due to lifting or handling, or other injuries? Please consider all situations when the equipment will be operated: at night; with MOPP gear; in rain or snow; in heat, etc. Also consider all aspects of the equipments' operation: movement from site to site; site setup; preparation for mission; actual mission operation, and site breakdown.

	Percentage of Yes responses by operators Response groups	Total	V2	V3	SC
	9.5 ft. Antenna				
120.	Reflector Hub	26	16	27	60
121.	Reflector Petals	20	21	18	20
122.	Rear Strut	14	5	9	60
123.	Az-El Assembly	23	26	9	40
124.	Legs	3	5	0	0
125.	Feedhorn and Struts	6	11	0	0
126.	Cables and winch	11	21	0	0
127.	Base Plates and Tension Towers	3	5	0	0
128.	Waveguide/Messenger Cable	11	16	9	0
129.	Other	6	5	9	0
	Quick Reaction Antenna				
130.	Extension Tubes	3	0	0	20
131.	Trailer	11	11	18	0
132.	Reflector Petals	9	5	18	0
133.	Reflector Hub	6	5	9	0
134.	Az-El Assembly	0	0	0	0
135.	Antenna Hoist Assembly	9	5	18	0
136.	Waveguide/Messenger Cable	6	0	18	0
137.	Pionjar Driver/Accesories	34	17	36	40
138.	Lightning Protection Assembly	63	53	73	80
139.	Ground Support Equipment	3	0	9	0
	V2/V3 Shelter				
140.	Power and Cable Connections(Internal)	9	5	9	0
141.	Power and Cable Connections(External)	14	5	9	60
142.	Power Supplies	0	0	0	0
143.	Amplifiers	0	0	0	0
144.	Converters	0	0	0	0
145.	Other Components	3	5	0	0

Comments on next page

Section Chiefs
Q120 (4) training needed to promote safety; need four persons for safety;
Q121 training needed to promote safety
Q122 (4) safety problem load/unload task; requires four people for safety;
Q123 clumsy task, possible injuries;
Q135 get tired cranking;
Q137 (3) heavy and too much noise; drive rod gets hot need gloves for task;
Q138 (4) need redesign on base plate (base is not stable); erection proceedure is dangerous
Q141 power connection difficult to put on properly

V2 Operators
Q120 (5) training needed to promote safety; need four persons for safety;
Q121 training needed to promote safety
Q122 (3) safety problem load/unload task; requires four people for safety; pivot ball released too soon;
Q123 clumsy task, possible injuries;
Q125 Feedhorn into stow case cut fingers;
Q126 cable a tripping hazard;
Q135 get tired cranking;
Q137 (6) heavy and too much noise; gets hot need gloves for task; need safet boots for operation;
Q138 (5) need redesign on base plate (base is not stable); erection proceedure is dangerous
Q141 power connection difficult to put on properly
Q145 need hearing protection for operator in the shelter;

V3 Operators
Q120 (4) need at least four people for safety;
Q123 (2) ackward and clumsy, possible injuries;
Q131 lowering legs can be dangerous;
Q135 (2) alot of work, very fatiguing;
Q136 injuried fingers doing this task; ackward task;
Q137 (3) causes back strain; difficult for short person to operate;
Q138 (5) need at least four people, a dangerous task;

146. Have you or others received any injuries during the conduct of this test while operating or maintaining AN/TRC-170 equipment? Please describe what you were working on and what caused the injury.

Percentage of Yes response by operators

Response groups	Total	V2	V3	SC
	57	53	64	60

Comments. Section chiefs reported broken finger, bruised hand, and an LPA mast dropped on the shoulder of a crewmember. V2 operators reported burned leg on Pionjar muffler, shock from HF radio, broken finger, sprained shoulder, cut hand on hoist cable, minor cuts and injuries. In one case an antenna leg popped out during teardown and knocked person to the ground. V3 operators reported injured fingers from waveguides and cables. One person broke a finger assembling AZ-EL on antenna. Sprained wrist, scraped knuckles, and hurt foot on ground rod.

147. Can AN/TRC-170 personnel effectively perform set-up and tear down duties in MOPP 2 gear?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	94	89	100	100

MOPP IV

Percentage of yes responses by operators

Response groups	Total	V2	V3	SC
	43	42	45	40

Comments. It takes excessive time in either MOPP II or IV. MOPP IV not possible in acceptable time.

148. Were there any problems associated with camouflaging the different AN/TRC-170 vehicles or equipment?

Percentage of yes response by operators

Response groups	Total	V2	V3	SC
	43	42	18	60

Comments. Camouflage catches and tears on shelter; must use antenna rear strut to climb up for installation; need hooks on back of antenna pedals to hookup camouflage; V2 antenna especially difficult to do; need training on how to camouflage equipment.

149. Is the working space in the V2 adequate for you and other team members to perform your respective tasks at all times during operations?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	100	100	100	100

150. Is the working space in the V3 adequate for you and other team members to perform your respective tasks at all times during operations?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	17	0	45	20

Comments

The V3 is too small and cramped = 7
A big person has a hard time moving arround in the V3. = 1
There should be a builtin chair. = 1
The shlter needs to be wider not longer. = 1
Maintainers had a problem. = 1

151. Do the location and size of the fault indicator lights make it easy to see when they are "on"?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	100	100	100	100

Comments

No comments
(HF)

152. Are the display dials readable and understandable?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	97	100	95	100

Comments

Three operators noted that dials near the floor are hard to read, operator must get down on floor with flashlight to read them.
(HF)

153. Have you observed any physical interface problems within AN/TRC-170 V2 or V3?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	29	21	45	20

Comments

Operators need training on link engineering with other Tri-TAC equipment. We were able to work out all attempted interfaces but it took time. Waveguides from other Tropo equipment would not fit connectors on AN/TRC-170 system.
(HF)

154. Are all labels easy to read and understand (inside the shelter, outside the shelter, on antenna equipment, etc)?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	97	100	100	80

Comments. Antenna labels, markings were painted over (n = 8) (HF)

155. Are the procedures for operating AN/TRC-170 consistent with other microwave systems you have operated or been trained on?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	74	63	82	100

Comments. The radio operations are similar, but antennas are very different. The system is different, but much easier to operate. The differences are easy to learn.

156. Are adequate prompts (cues) displayed when operator action is required?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	94	100	82	100

Comments. The only problem is when the van is green, but no commo due to switch settings. (HF)

157. Is the labeling consistent with that on other systems you've used?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	77	74	91	60

Comments. Some of the labels are different, it just takes getting used to them. (HF)

158. Have you ever had problems because control actions are not consistent with what you are used to (in other systems, personal equipment, etc.)?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	6	5	0	20

Comments
(TR 3.1.9.1.1)

159. Are the groupings of controls with similar functions satisfactory? (They should be grouped together so that performing an operation is made as easy as possible.)

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	91	95	91	80

Comments
The only problem is antenna adjustment.
(HF)

160. Are there any other control or switch problems you have encountered? For example, size for your fingers--can you push the buttons? Your recommendations for solutions would be appreciated.

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	11	11	0	40

Comments
(HF)

161. Do you think the spacing and arrangement of the controls and switches needs to be changed?

Percentage of Yes response by operators

Response groups	Total	V2	V3	SC
	6	11	0	0

Comments. One operator requested more space between and maybe longer switches on lqm/tqm/qm. Another reported that the headset cable trips loopback switch on the if test panel, this should be changed. (HF)

162. Are there any switches in which the control positions are not in a logical order?

Percentage of yes response by operators

Response groups	Total	V2	V3	SC
	0	0	0	0

Comments. The orderwire should be in the center or put a longer cord on the headset. The sequencing on the receivers is confusing. (HF)

163. Are any of the controls or switches hard to reach?

Percentage of Yes response by operators

Response groups	Total	V2	V3	SC
	3	0	9	0

Comments. One operator reported that on dgm equipment, the trip switch is hard to reach because of piece (protection). (HF)

164. Does the arrangement of major components in the V2 shelter (amplifiers, power supplies, patch panels, LGM, TGM, etc.) make them easy to set up, monitor, and service?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	91	89	91	100

(TR 3.1.1.1.10)

165. Does the arrangement of major components in the V3 shelter (amplifiers, power supplies, patch panels, LGM, TGM, etc.) make them easy to set up, monitor, and service?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	57	42	82	60

Comments

A problem for a big person to move arround in the van. = 1
Difficult to monitor components on both sides of the van = 1
The van is too small. = 7
Maintenance has major problem. = 1
(TR 3.1.1.1.10))

166. Are there any parts of the site and antenna set-up for the V2 antenna system that are difficult in terms of time and effort needed to accomplish the tasks?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	54	63	36	60

Comments

Section Chiefs
The anchors are not suitible for all terrains, we need some kind of substitute. Crew size a problem, effectiveness reduced by fatigue.
V2 & V3 operators
The drilling and setting of anchors = 12
The V2 antenna needs redesign = 4
The LPA needs new design (new base plate) = 2
The alignment task for the antenna center hub = 3
(TR 3.1.5.1.3)

167. Are there any parts of the site and antenna set-up for the V3 antenna system that are difficult in terms of time and effort needed to accomplish the tasks?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	20	16	27	20

Comments

The V3 could use a larger crew. = 2
The anchors are a problem = 6
The LPA needs a new design (change base plate) = 4

(TR 3.1.5.1.3)

168. In your opinion should the AN/TRC-170(V2) continue to use the current mobilizer as its prime mode of transportation?

Percentage of Yes responses by operators

Response groups	Total	V2	V3	SC
	3	0	9	0

Comments

3
V2 = 0
V3 = 9
SC = 0
The V2 should be mounted upon a heavy duty mobilizer = 6
The M720 mobilizer is unsafe (too limited capacity) = 3
The V2 should be mounted upon a truck (5-ton) = 17

(TR 3.1.8)

~~AN/TRC-170~~ MAINTAINERS INTERVIEW

All references to questions in this interview give the question number preceeded by the letter "M".

Respondant Demographics:

MAINTAINERS: N = 3 MOS: 29M

GRADE: E4
3

AVERAGE AGE	AVERAGE TIME IN	
27.6	Military = 3.8 YEARS	MOS = 2.6 YEARS

AVERAGE CIVILIAN EDUCATION = 12.6 YEARS

AVERAGE MILITARY EDUCATION = 13.6 MONTHS

MILITARY SCHOOLS ATTENDED (AVERAGE) = 3

Have you experienced any difficulties with the removal, repair, or replacement of the following items on the AN/TRC-170?

Responses by percentage	Yes	No
1. RF Amplifier	0	100
2. Control Logic Assembly	0	100
3. Control Logic Assembly Circuit Cards	0	100
4. High Voltage Power Supply	33	67
5. Fast Interrupt (FAINT) Assembly	0	100
6. Inverters	0	100
7. RF Protect and Metering	0	100
8. Klystron	67	33
9. Amplifier Up-converter Assembly	0	100
10. Downconverter Assembly	0	100
11. Dual RF Synthesizer	0	100
12. Tropo Modem Modulator	33	67
13. Tropo Modem Demodulator	33	67
14. TED 1 and 2	33	67
15. COMSEC gear in general	33	67
16. Low Voltage Power Supply	0	100
17. Baseband Patch Panel	0	100
18. Loop Group Multiplexer (LGM-1)	0	100
19. Group Modem	0	100
20. Trunk Group Multiplexer	0	100
21. LGM-2/LSCDM	0	100
22. Ac to Ac Converter	67	33
23. V2 mobilizer	33	67
24. Alarm Monitor	0	100
25. Orderwire Control Unit	67	33
26. IF Test Panel	0	100
27. Heater Assembly	0	100
28. Analog Voice Orderwire Unit	0	100
29. Noise Source	0	100
30. Flushing Fan	0	100
31. Remote Orderwire Control Unit (ROCU)	33	67
32. LED Matrix Circuit card assembly	0	100
33. Heat Sensor Warning Switch	0	100
34. Centrifugal Fan	0	100
35. Tube axial Fans (specify)	0	100
36. Vane axial Fan	0	100

Comments:

Q04 needed special tools only Raytheon had them.
Q08 difficult remove/replace.
Q12 & Q13 problem trouble shooting, fault light on but the problem is not in the tropomodem.
Q14 problem loading the TEDs.
Q15 problem trouble shooting COMSEC interface.
Q22 failures had to be referred to Raytheon.
Q25 orderwire locks up (2).
Q31 ROCUs have to be turned into Raytheon.

37. Were there any situations during equipment diagnosis, repair or checkout that BITE was used but it was not designed to detect the problem encountered?

YES = 33% NO = 67%

Comments: In the VOCU a fault light on CCA, but found VINCINT buffer, electronic bridge were defective. Light not on in them. BITE did not give adequate diagnosis.

38. Were there any situations during equipment diagnosis or checkout when BITE was not used but it should have been?

YES = 0% NO = 100%

39. Were adequate alternative diagnostic procedures available when BITE/TMDE was not?

YES = 67% NO = 33%

Comments: e.g. swapping cards.

40. Overall, were equipment failures easy to recognize during configuration, set-up, and operation?

YES = 100% NO = 0%

Comments: COMSEC gear a problem.

Do you believe that with the training and experience you have had to date that you are SQT-qualified on the following operations - related tasks? Use N/A only if you have not done the task during the test. (Circle Answer)

Responses by percentage	Yes	No
41. Configuring the system with assignment sheet....	67	33
42. Calibrating/Adjusting the Shelter Components....	67	33
43. Recognizing faults during configuration set-up..	67	33
44. Fault diagnosis using BITE.....	100	0
45. Fault isolation using the flow charts.....	100	0
46. Fault diagnosis without BITE.....	67	33
47. Conducting Performance Test Checks.....	100	0
48. Performing PMCS.....	33	67
49. Removing/Replacing Shelter Components.....	100	0
50. Site Layout.....	33	67
51. 9.5 ft. Antenna Assembly.....	67	33
52. 9.5 ft. Antenna Disassembly.....	67	33
53. QRA Antenna Assembly.....	67	33
54. QRA Antenna Assembly.....	67	33
55. Antenna Adjustment and alignment.....	100	0

Comments: Q49 cards yes, other components no.

56. Will the supply allocations and procedures for AN/TRC-170 be compatible with the existing Army Supply System?

YES = 67% NO = 33%

Comments: need more spares and many items not in system yet

57. Were the maintenance authorizations and organization adequate?

YES = 67% NO = 33%

Comments: not enough maintainers.

58. Is the current assignment strategy of operations and maintenance personnel adequate for effective mission performance?

YES = 33% NO = 67%

Comments: crew size needs to be increased and there are not enough maintainers.

59. Are common and special tools supplied with AN/TRC-170 equipment adequate for effective mission performance?

YES = 100% NO = 0%

Comments: could use screwdriver tips with ratchet handles and long handled allen wrenches with ratchets.

60. Is TMDE and Calibration equipment for AN/TRC-170 adequate?

YES = 67% NO = 33%

Comments: SG11139 is not adequate. Can only do one of 3 tests possible with Raytheon Loop-Test sets.

61. Are you able to perform all the maintenance tasks assigned for TRC-170?

YES = 67% NO = 33%

Comments: We do not have all the parts.

62. Are there any changes in equipment design or location needed to change peripherals or install spares?

YES = 33% NO = 67%

Comments: V2 is OK, but not enough room in the V3.

63. Have you observed any situations where the operator or maintainer had to reach or climb in a manner that was not safe? (For example they should of had a ladder).

YES = 33% NO = 67%

Comments: need a ladder.

64. Do the TMs have adequate logistics support procedures documentation?

YES = 33% NO = 67%

Comments: Documentation not available.

65. Is the MAC effective in its present form?

YES = 100% NO = 0%

Comments:

66. Are the fault isolation and repair flowcharts easy to follow?

YES = 100% NO = 0%

Comments: need to be taught how to read them.

67. Are the fault isolation and repair flowcharts correct?

YES = 100% NO = 0%

Comments:

68. In your opinion should the location of items on the low profile pallet or in the shelter be changed? For example move the accessory kit to the shelter or truck?

YES = 33% NO = 67%

Comments:

69. Are there any problems you've encountered with the TM? Your recommended solutions and improvements would be appreciated.

YES = 0% NO = 100%

Comments:

70. Overall, are AN/TRC-170 parts easy to remove, repair and replace?

YES = 100% NO = 0%

Comments:

Are the maintainers able to perform the following tasks well enough to pass an SQT?

Response percentages	Yes	No
71. Remove/Replace AC-AC converters.....	100	0
72. Remove/Replace Klystron.....	100	0
73. Adjust Klystron.....	100	0
74. Troubleshoot Tropomodem.....	100	0
75. Troubleshoot Transmitter.....	100	0
76. Remove/Replace circuit cards.....	100	0

Comments:

77. Do you believe that special physical or mental abilities over and above those already specified are required to operate and maintain the AN/TRC-170?

YES = 0% NO = 100%

Comments:

78. Have you observed any physical interface problems with AN/TRC-170? (i.e. cables, waveguide, etc.)

YES = 33% NO = 67%

Comments: waveguide.

79. Are any changes required or do you have any recommendations for changes to the logistics support concept or procedures that would increase tactical mobility?

YES = 33% NO = 67%

Comments:

80. In your opinion are the anchors (duckbills) used for the 9 and 1/2 foot antenna and the LPA an effective system for the AN/TRC-170 in tactical circumstances?

YES = 33% NO = 67%

Comments: Anchor should be able to be removed after use.

81. Do you have any further recommendations for changes to the proposed logistics and maintenance concept?

YES = 33% NO = 67%

Comments: Need one risk kit per site.

82. Were personnel able to effectively perform configuration set-up functions in MOPP 4 gear? (HF)

YES = 100% NO = 0%

Comments: as far as I know - did not see them do it.

83. Are the AN/TRC-170 V2 and V3 shelters, equipment, antennas, and support equipment rugged enough to withstand continued field use?

YES = 67% NO = 33%

Comments: Pins are not strong enough.

84. Did you have any problems reaching any of the sites used in the test due to lack of mobility of the AN/TRC-170 equipment?

YES = 0% NO = 100%

During the test have you noticed any differences between the AN/TRC-170 and the equipment it is supposed to replace in terms of ease of operation, ease of set-up/teardown, ease of maintenance (diagnosis, calibration, removal and replacement)?

Response Percentages	Yes	No
85. Ease of operation	67	33
86. Ease of Set-up	33	67
87. Ease of teardown	33	67
88. Ease of diagnosis for maintenance	67	33
89. Ease of calibration	33	67
90. Ease of component removal	67	33
91. Ease of component repair	33	67
92. Ease of configuration set-up	67	33
93. Safety	33	67
94. Reliability	67	33

Comments:

95. In your opinion are there any aspects of environment such as illumination, noise, ventilation, temperature, vibration, and climate that pose a potential problem for AN/TRC-170 maintainers?

YES = 33% NO = 67%

Comments: Shelter is too noisy.

96. Were personnel able to effectively perform maintenance functions in MOPP 2 gear?

YES NO Did not do this task.

97. Were personnel able to effectively perform maintenance functions in MOPP 4 gear?

YES NO did not do this task.

Comments:

98. Are the diagnostic outputs of the AN/TRC-170 equipment easy to use?

YES = 100% NO = 0%

Comments:

99. In your opinion, is the AN/TRC-170 BITE effective for system maintenance?

YES = 100% NO = 0%

Comments: with the exception of the VOCU.

100. In your opinion, would the AN/TRC-170 be effective (if fielded in its present form) for aiding signal/communications missions?

YES = 100% NO = 0%

Comments:

101. Have you had any difficulty understanding the AN/TRC-170 maintenance problems?

YES = 33% NO = 67%

Comments: end-to-end trouble shooting.

102. Is the overall operation of the AN/TRC-170 equipment effective?

YES = 100% NO = 0%

Comments:

103. In your opinion does AN/TRC-170 have "operational utility" (is it useful and do we need it)?

YES = 100% NO = 0%

Comments:

104. Are AN/TRC-170 maintenance procedures easy?

YES = 100% NO = 0%

Comments:

105. Are maintenance procedures confusing or difficult in any ways not already described? Please discuss.

YES = 0% NO = 100%

Comments:

106. Have you ever noticed any of the codes and/or procedures used in the maintenance/repair of AN/TRC-170 that are confusing or need to be changed?

YES = 0% NO = 100%

Comments:

SAFETY

Have you or others observed potential or actual safety hazards that could result in shock, burns, falls, cuts, bruises, explosions, entanglements in moving parts, strains due to lifting or handling, or other injuries? Please consider all situations when the equipment will be operated: at night; with MOPP gear; in rain or snow; in heat, etc. Also consider all aspects of the equipments' operation: movement from site to site; site setup; preparations for mission; actual mission operation, and site breakdown.

Please answer for each equipment component.

	Response Percentages	Yes	No.
	9.5 ft. Antenna		
107.	Reflector Hub	33	67
108.	Reflector Petals	33	67
109.	Rear Strut	0	100
110.	Az-El Assembly	33	67
111.	Legs	0	100
112.	Feedhorn and Struts	0	100
113.	Cables and winch	0	100
114.	Base Plates and Tension Towers	0	100
115.	Waveguide/Messenger Cable	33	67
116.	Other	0	100
	Quick Reaction Antenna		
117.	Extension Tubes	0	100
118.	Trailer	0	100
119.	Reflector assembly	0	100
120.	Az-El Assembly	0	100
121.	Antenna Hoist Assembly	0	100
122.	Waveguide/Messenger Cable	33	67
123.	Pionjar Driver/Accessories	33	67
124.	Lightning Protection Assembly	67	33
125.	Ground Support Equipment	0	100
	V2/V3 Shelter		
126.	Power and Cable Connections(Internal)	0	100
127.	Power and Cable Connections(External)	0	100
128.	Power Supplies	0	100
129.	Amplifiers	0	100
130.	Converters	0	100
131.	Other Components	0	100

Comments: LPA needs four people.

132. Have you or others received any injuries during the conduct of this test while operating or maintaining AN/TRC-170 equipment? Please describe what you were working on and what caused the injury.

YES = 0% NO = 100%

Comments:

133. Do the location and size of the fault indicator lights make it easy to see when they are "on"?

YES = 100% NO = 0%

Comments:

134. Are the display dials readable and understandable?

YES = 100% NO = 0%

Comments:

135. Are all labels easy to read and understand (inside the shelter, outside the shelter, on antenna equipment, etc)?

YES = 100% NO = 0%

Comments:

136. Are the procedures for maintaining AN/TRC-170 consistent with other microwave systems you have maintained or been trained on?

YES = 67% NO = 33%

Comments:

137. Is the labeling consistent with that on other systems you've used?

YES = 67% NO = 33%

Comments: had to learn new terminology.

138. Do you feel the amount of training given was adequate considering the backgrounds and skill levels of the students?

YES = 100% NO = 0%

Comments:

139. Is there enough room in the V2 shelter to remove and replace all the components from the racks safely and efficiently?

YES = 100% NO = 0%

Comments:

140. Is there enough room in the V3 shelter to remove and replace all the components from the racks safely and efficiently?

YES = 0% NO = 100%

Comments: too small in the V3.

141. Is there enough room within major components (e.g.high power amplifier, LGM, downconverter, etc.) to service or remove and replace parts safely and efficiently?

YES = 100% NO = 0%

Comments: access to HPA a problem.

142. Does the arrangement of major components in the V2 shelter (amplifiers, power supplies, patch panels, LGM, TGM, etc.) make them easy to set up, monitor, and service?

YES = 100% NO = 0%

Comments:

143. Does the arrangement of major components in the V3 shelter (amplifiers, power supplies, patch panels, LGM, TGM, etc.) make them easy to set up, monitor, and service?

YES = 100% NO = 0%

Comments:

Can any three persons who can hold the 26Q MOS and proper skill identifier perform the following tasks? (The issue here is size and physical strength)

	Response Percentage	Yes	No
144.	Erection of the LPA.....	0	100
145.	Disassemble the LPA.....	33	67
146.	Unload the low profile pallet.....	0	100
147.	Erect the 9 1/2 Ft. antenna.....	0	100
148.	Disassemble the 9 1/2 Ft. antenna.....	0	100
149.	Maneuver the V2 shelter into position... (Assuming use of the mobilizer alone)	0	100
150.	Maneuver the QRA into position.....	67	33
151.	Install a complete set of anchors..... (Assumes 22 anchors and a time limit)	0	100
152.	Get TRC-170 V2 operational in 5 hours...	33	67

Comments: Fatigue would be a major problem.

In your opinion, how many persons are required to perform the following setup and teardown tasks safely and efficiently on the AN/TRC-170 V2?

Tasks	Persons Required
153. LPA erection.....	4.0
154. LPA lowering.....	4.0
155. 9 & 1/2 ft. antenna erection....	4.0
156. 9 & 1/2 ft. antenna lowering....	4.0
157. Load/unload low profile pallet..	4.0
158. Position V2 mobilizer/shelter...	5.5
159. Set anchors with Pionjar.....	4.5

Comments: fatigue a problem.

160. In your opinion should the AN/TRC-170(V2) continue to use the current mobilizer as its prime mode of transportation?

YES = 0% NO = 100%

Comments: put it on a 5-ton.

161. Are there any maintenance procedures which are not in a logical order?

YES = 0% NO = 100%

Comments: VOCU procedures flowchart.

TEST DIRECTORATE INTERVIEW

All references to questions in this interview give the question number preceeded by the letter "T".

Respondant Demographics:

Ranks = Civ = 4; E-5 = 1; E-6 = 3; E-7 = 3; O-2 = 1

Average age = 37.9

MOS: 25A = 1; 29V = 1; 29M = 2; 31M = 1; 31Z = 1;
32Z = 1; 72G = 1.

Average time in MOS = 7.8 years

Average years of military service = 13.2 years

Average years of civilian education = 16.0 years

Average months of military education = 19.6 months

Average number of military schools attended = 6

Have you observed any difficulties with the set-up or operation of the following items on the AN/TRC-170?

		Percentage of Yes	No
1.	RF Amplifier	8	92
2.	Control Logic Assembly	0	100
3.	Control Logic Assembly Circuit Cards	8	92
4.	High Voltage Power Supply	8	92
5.	Fast Interrupt (FAINT) Assembly	8	92
6.	Inverters	0	100
7.	RF Protect and Metering	17	83
8.	Klystron	42	58
9.	Amplifier-converter Assembly	0	100
10.	Downconverter Assembly	0	100
11.	Dual RF Synthesizer	8	92
12.	Tropo Modem Modulator	8	92
13.	Tropo Modem Demodulator	0	100
14.	TED 1 and 2	42	58
15.	DLED 1 and 2	8	92
16.	Low Voltage Power Supply	0	100
17.	Baseband Patch Panel	8	92
18.	Loop Group Multiplexer	17	83
19.	Group Modem	25	75
20.	Trunk Group Multiplexer	17	83
21.	LGM/LSCDM	8	92
22.	Ac to Ac Converter	8	92
23.	DLED Patch Panel	0	100
24.	Alarm Monitor	0	100
25.	Orderwire Control Unit	50	50
26.	IF Test Panel	0	100
27.	Heater Assembly	25	75
28.	Analog Voice Orderwire Unit	0	100
29.	Noise Source	0	100
30.	Flushing Fan	17	83
31.	Remote Orderwire Control Unit	8	92
32.	LED Matrix CCA	8	92
33.	Heat Sensor Warning Switch	0	100
34.	Centrifugal Fan	0	100
35.	Tube axial Fans (specify)	0	100
36.	Vane axial Fan	0	100

Comments:	Number of responses
Q4 remove/replace problem	= 1
Q5 interrupt not sensitive enough.	= 1
Q7 get false readings	= 3
Q8 difficult to remove/replace.	= 5
Q11 false readings	= 2
Q12 false readings	= 2
Q14 Operators need more training	= 3
Q17 Operators need more training	= 1
Q19 failure rate high	= 1
Q22 need different fan setup	= 1
Q25 bridge locks up	= 4
Q27 heaters do not work (need ECU)	= 2
Q31 false readings - does not work	= 2
Q32 LEDs need labels (TR 3.1.1.1.10)	= 1

37. Were there any situations during equipment diagnosis, repair or checkout that BITE was used but it was not designed to detect the problem encountered?

Yes = 42% No = 58%

Comments:
BITE (fault lights) gave false information.
We can not distinguish between D/E and local problems.
Frequently could not detect problem with BITE.
(TR 3.1.1.1.15e)

38. Were there any situations during equipment diagnosis or checkout when BITE was not used but it should have been?

Yes = 42% No = 58%

Comments
Operators need more training in troubleshooting. = 3
(TR 3.1.1.1.15f)

39. Were adequate alternative diagnostic procedures available when BITE/TMDE was not?

Yes = 33% No = 67%

Comments
Operators were lax on using TM, called Raytheon instead. = 3
Reported problems in the flow charts for VOCU = 1
(TR 3.1.1.1.15f)

40. Overall, were equipment failures easy to recognize during configuration set-up and operation?

Yes = 67% No = 33%

Comments
Operators were not trained in system troubleshooting = 3
(TR 3.1.1.1.16)

Do you believe that with the training and experience the operators/maintainers have had to date that they are SQT-qualified on the following operations - related tasks? Use N/A only if the task was not done during the test. (Circle Answer)

	Percentage of Yes	No
41. Configuring the system with assignment sheet.....	75	25
42. Calibrating/Adjusting the Shelter Components.....	83	17
43. Recognizing faults during configuration set-up...	67	33
44. Fault diagnosis using BITE.....	75	25
45. Performing PMCS.....	67	33
46. Removing/Replacing Shelter Components.....	50	50
47. Site Layout.....	75	25
48. 9.5 ft. Antenna Assembly.....	83	17
49. 9.5 ft. Antenna Disassembly.....	83	17
50. QRA Antenna Assembly.....	83	17
51. QRA Antenna Disassembly.....	83	17
52. Antenna Adjustment.....	75	25
53. LPA Assembly/Erection.....	83	17
54. Pionjar operation/maintenance.....	75	25
55. Pocket Transit operation & interpretation.....	67	33

Comments:

Q43 only 60% of operators would pass = 2
Q45 operators need better training = 2
Q54 operators not trained properly = 5
Q55 operators not trained on M2 compass = 4
(TR 3.1.1.1.18)

56. Will the supply allocations and procedures for AN/TRC-170 be compatible with the existing Army Supply System?

Yes = 25% No = 75

Comments

The Pionjar ia a problem (fuel, parts, spares) = 2
The AN/TRC-170 is not yet in the system = 9
(TR 3.1.2.1.2)

57. Was the maintenance authorizations and organization adequate?

Yes = 25% No = 75%

Comments

Need more risk kits	=	3
Operators should be trained as level 1 maintainers	=	3
Operators should be authorized to do maintenance	=	4

(TR 3.1.2.1.3)

58. Is the current assignment strategy of operations and maintenance personnel adequate for effective mission performance?

Yes = 0% No = 100%

Comments

Need more maintainers (at least one per site)	=	8
The crew size should be larger (at least 4 people)	=	7

(TR 3.1.2.1.3)

59. Are common and special tools supplied with AN/TRC-170 equipment adequate for effective mission performance?

Yes = 33% No = 67%

Additional tool requested by number of responses.

Rubber mallet	=	2
Punch for antenna pins	=	1
Non-ferrous tools (Klystron)	=	2
Large crescent wrench	=	1
Nut drivers	=	1
Ladder	=	1
Tape measure	=	1
Generator wrench	=	1

(TR 3.1.3.1.2)

60. Is TMDE and Calibration equipment for AN/TRC-170 adequate?

Yes = 25% No = 75%

Comment

There was no calibration or test equipment available	=	3
No training on signal generator supplied	=	2
Need a better multimeter	=	1

(TR 3.1.3.1.3&4)

61. Are the operators able to perform all the maintenance tasks assigned to operators for TRC-170?

Yes = 100%

Comments

Operators should be authorized to do more maintenance	=	7
Operators should be authorized to do maintenance	=	1

(TR 3.1.3.1.5)

62. Are there any changes in equipment design or location needed to change peripherals or install spares?

Yes = 50% No = 50%

Comments

V3 is too small for remove/replace tasks	=	2
Klystron remove/replace a problem	=	2
Need space for cable drivers without replacing	=	1
V2 weight/balance needs redesign	=	1
Handles for low voltage power supply	=	1

(TR 3.1.3.1.10)

63. Should any items be added to or deleted from the PLL or ASL?

Yes = 42% No = 58%

Comments

Increase the number of risk kits	=	5
Pionjar accessories, parts, expendables	=	1
Ladder issed to each system	=	2
Anchors and antenna pins (need more per unit)	=	1

(TR 3.1.3.1.12)

Can any three persons who can hold the 26Q MOS and proper skill identifier perform the following tasks? (The issue here is size and physical strength)

	Percentage of Yes	No responses
64. Erection of the LPA.....	8	92
65. Disassemble the LPA.....	17	83
66. Unload the low profile pallet.....	42	58
67. Erect the 9 1/2 Ft. antenna.....	25	75
68. Disassemble the 9 1/2 Ft. antenna.....	33	67
69. Maneuver the V2 shelter into position... (Assuming use of the mobilizer alone)	8	92
70. Maneuver the QRA into position.....	75	25
71. Install a complete set of ground stakes. (Assumes 24 stakes and a time limit)	58	42
72. Get TRC-170 V2 operational in 5 hours...	25	75

Comments:

Q64-65 need at least four people with current design = 3
Q66 fatigue a real problem with small crew (need 4) = 3
Q72 could not be done safely = 2
(TR 3.1.4.1.1)

73. Did the crew size used in the test provide enough people during tactical situations to accomplish all other tasks required to operate and maintain the AN/TRC-170 (V2)?

Yes = 17% No = 83%

Comments

Crew size would have to be increased to at least 6 to meet tactical requirements. = 5
(TR 3.1.4.1.1)

74. Did the crew size used in the test provide enough people during tactical situations to accomplish all other tasks required to operate and maintain the AN/TRC-170 (V3)?

Yes = 42% No = 58%

Comments

Crew size would have to be increased to at least 6 to meet tactical requirements. = 5

(TR 3.1.4.1.1)

Are the operators able to perform the following tasks well enough to pass an SQT?

	Percentage of Yes	No responses
75. Site layout (Azimuth determination).....	75	25
76. Setting anchors (using Pionjar).....	83	17
77. Adjust Klystron.....	83	17
78. Align Antennas.....	75	25
79. Assemble 9 1/2 Ft. Antenna.....	92	8
80. Understand/Use Crew Assignment Sheet.....	67	33

Comments:

Operators OK only because of intense ojt, otherwise need more training.

(TR 3.1.4.1.2)

81. Do you believe that special physical or mental abilities over and above those already specified are required to operate and maintain the AN/TRC-170?

Yes = 42% No = 58%

Comments

Need bigger/stronger personnel (unless crew size is increased) = 5
The MOS should be restricted to above CAT III personnel = 1

(TR 3.1.4.1.4)

82. Have you or others identified critical tasks that were not included in training?

Yes = 67% No = 33%

Tasks include:

Generator operation/PMCS	= 2
Pionjar operation/PMCS	= 6
Troubleshooting end-to-end	= 4
Training on COMSEC interface	= 3

(TR 3.1.6.1.6)

83. Are the AN/TRC-170 V2 and V3 shelters, equipment, antennas, and support equipment rugged enough to withstand continued field use?

Yes = 25% No = 75%

Comments

Mobilizers not rugged enough	= 7
Antenna pins break too easily	= 5
LPA baseplate breaks easily	= 3
Antenna wrench & cable	= 1
Antenna anchors	= 2
Waveguides	= 1

(TR 3.1.7.1.1)

84. Did crews have any problems reaching any of the sites used in the test due to lack of mobility of the AN/TRC-170 equipment?

Yes = 58% No = 42%

Comments

Selection of sites for use in the test was effected by mobility = 7

(TR 3.1.7.1.2)

In your opinion, how many persons are required to perform the following setup and teardown tasks safely and efficiently on the AN/TRC-170 V2?

Tasks	Average response # Persons Required
85. LPA erection.....	3.7
86. LPA lowering.....	3.5
87. 9 & 1/2 ft. antenna erection....	3.8
88. 9 & 1/2 ft. antenna lowering....	3.7
89. Load/unload low profile pallet..	3.2
90. Position V2 mobilizer/shelter...	4.7
91. Set anchors with Pionjar.....	2.7

Comments:

Q85-86 need to redesign baseplate = 2
Q90 this should not be done manually = 2
(TR 3.1.7.1.7)

In your opinion, how many persons are required to perform the following setup and teardown tasks safely and efficiently on the AN/TRC-170 V3?

Tasks	Average response # Persons Required
92. LPA erection.....	3.7
93. LPA lowering.....	3.5
94. QRA antenna erection.....	2.2
95. QRA antenna lowering.....	2.2
96. Position 10kw generator.....	2.2
97. Position QRA trailer.....	2.5
98. Set anchors with Pionjar.....	2.4

Comments:

Q92-93 need to redesign baseplate = 2
(TR 3.1.7.1.7)

99. Do the TMs have adequate logistics support procedures documentation?

Yes = 25% No = 75%

Comments
The manuals do not tell where to get required spare parts = 4
(TR 3.1.2.11)

100. Is the Organization and Operational (O&O) Plan for the AN/TRC-170 consistent with the existing Army Supply System?

Yes = 17% No = 83%

Comments
The current O&O is not consistent with Army supply system yet = 5
(TR 3.1.2.1.3)

During the test have you noticed any differences between the AN/TRC-170 and the equipment it is supposed to replace in terms of ease of operation, ease of set-up/teardown, ease of maintenance (diagnosis, calibration, removal and replacement)?

Record#	Q101	Q102	Q103	Q104	Q105	Q106	Q107	Q108	Q109	Q110
	10	7	9	9	8	7	5	10	6	9

	Percentage of responses	Yes	No
101.	Ease of operation	83	17
102.	Ease of Set-up	58	42
103.	Ease of teardown	75	25
104.	Ease of diagnosis for maintenance	75	25
105.	Ease of calibration	67	33
106.	Ease of component removal	58	42
107.	Ease of component repair	42	58
108.	Ease of configuration set-up	83	17
109.	Safety	50	50
110.	Reliability	75	25

Comments:
Q102-103 not easier due to anchors and V2 antenna = 5
Q109 safety is effected by manning = 2
(TR 3.1.9.1.1)

111. In your opinion are there any items of environment such as illumination, noise, ventilation, temperature, vibration, and climate that pose a potential problem for AN/TRC-170 operators?

Yes = 67% No = 33%

Comments

Noise level in the vans	= 6
Heat/cold need an ECU	= 4
Pionjar is hot and noisy	= 2

(MANPRINT)

112. Were personnel able to effectively perform configuration set-up functions in MOPP 4 gear?

Yes = 75% No = 25%

Comments

MOPP IV can be done, but would be very slow = 2

(MANPRINT)

113. Is the MAC effective in its present form?

Yes = 17% No = 83%

Comments

The operators should do more maintenance tasks = 6

(TR 3.1.2.1.3)

114. In your opinion, is the AN/TRC-170 BITE effective for system operations and maintenance?

Yes = 83% No = 17%

Comment

Operators could use more training in troubleshooting.

(MANPRINT)

115. In your opinion, would the AN/TRC-170 be effective (if fielded in its present form) for aiding signal-communications missions?

Yes = 67% No = 33%

Comments

The V2 mobilizer needs to be replaced	= 2
The vans should each have a risk kit	= 1
Operators should be trained as maintainers	= 1
The V3 antenna is not tactical	= 1

(TR 3.1.9.1.1)

116. Overall, is the logistics support concept for the AN/TRC-170 adequate?

Yes = 8% No = 92%

Comments

The support concept still needs work = 5
(3.1.2.1.3)

117. Is the overall operation of the AN/TRC-170 equipment effective?

Yes = 83% No = 17%

Comments

The support equipment has been causing some problems. Mobilizer, 10kw generator, and 2.5 ton truck for the V3.
(TR 3.1.9.1.1)

118. Have you observed any physical interface problems with AN/TRC-170?

Yes = 67% No = 33%

Comments

Waveguide pins and latching	= 2
Generator cable on the V3 shelter	= 2
Generator cable on the 10kw generator	= 2
The TTC-73 was a minor problems with synch and direct connect teletype.	= 2

(TR 3.1.8.1.6)

119. In your opinion does AN/TRC-170 have "operational utility" (is it useful and do we need it)?

Yes = 92% No = 8%

Comment

The AN/TRC-170 is necessary.
(MANPRINT)

SAFETY

Have you or others observed potential or actual safety hazards that could result in shock, burns, falls, cuts, bruises, explosions, entanglements in moving parts, strains due to lifting or handling, or other injuries? Please consider all situations when the equipment will be operated: at night; with MOPP gear; in rain or snow; in heat, etc. Also consider all aspects of the equipments' operation: movement from site to site; site setup; preparation for mission; actual mission operation, and site breakdown.

	Percentage of responses	Yes	No
	9.5 ft. Antenna		
120.	Reflector Hub	50	50
121.	Reflector Petals	50	50
122.	Rear Strut	42	58
123.	Az-El Assembly	50	50
124.	Legs	42	58
125.	Feedhorn and Struts	17	83
126.	Cables and winch	42	58
127.	Base Plates and Tension Towers	33	67
128.	Waveguide/Messenger Cable	42	58
129.	Other	8	92
	Quick Reaction Antenna		
130.	Extension Tubes	25	75
131.	Trailer	42	58
132.	Reflector Petals	17	83
133.	Reflector Hub	17	83
134.	Az-El Assembly	17	83
135.	Antenna Hoist Assembly	25	75
136.	Waveguide/Messenger Cable	33	67
137.	Pionjar Driver/Accesories	58	42
138.	Lightning Protection Assembly	75	25
139.	Ground Support Equipment	42	58
	V2/V3 Shelter		
140.	Power and Cable Connections(Internal)	0	100
141.	Power and Cable Connections(External)	25	75
142.	Power Supplies	0	100
143.	Amplifiers	0	100
144.	Converters	0	100
145.	Other Components	25	75

Comments:

Q120, 121, 132, 133: in high wind and/or slippery ground.
Q122: remove/replace on pallet or use 4 to load.
Q123: care on assemb/dissamble, se 4 as there is awkward positioning.
Q128/136 waveguide suseptable to change.
Q137: need steel tip boot, earpluges, ladder = 3
Q138 LPA is dangerous with current baseplate.
(MANPRINT)

146. Is the information in the AN/TRC-170 technical manuals presented clearly?

Yes = 83% No = 17%

Comments

The manuals have too much unneeded information = 3
The manuals are confusing and information is hard to find = 2
(TR 3.1.2.1.3)

147. Can AN/TRC-170 personnel effectively perform set-up and tear down duties in MOPP 2 & 4 gear?

Yes = 58% No = 42%

Comments

Tasks would take a lot more time in MOPP gear. = 2
V2 antenna is not possible in MOPP IV. = 1
(MANPRINT)

148. Were there any problems associated with camouflaging the different AN/TRC-170 vehicles or equipment?

Yes = 8% No = 92%

Comment

Units needed to provide 'how to' procedures on camoflage, provide a ladder.
(MANPRINT)

149. Is the working space in the V2 adequate for the operators and crews to perform their respective tasks at all times during operations?

Yes = 92% No = 8%

Comment

Bad arrangement, no place to sit, no work table, etc.
(MANPRINT)

150. Is the working space in the V3 adequate for the operators and crews to perform their respective tasks at all times during operations?

Yes = 8% No = 92%

Comments

The V3 is too small = 5
(MANPRINT)

151. Is it easy to look up or locate information related to a specific problem in the technical manuals?

Yes = 17% No = 83%

Comments

The manuals are in too many volumes and are not cross referenced = 5
(TR 3.1.6.1.5)

152. Are the fault isolation and repair flowcharts easy to follow?

Yes = 50% No = 50%

No comments
(TR 3.1.6.1.5 & 3.1.2.1.3)

153. Have you observed any physical interface problems within AN/TRC-170 V2 or V3?

Yes = 25% No = 75%

Comments

Interface with other TRI-TAC gear a problem (need training) = 2
The documentation for interface is confusing = 1
COMSEC interfaces are a big problem = 2
(TR 3.1.8.1.1)

154. Are all labels easy to read and understand (inside the shelter, outside the shelter, on antenna equipment, etc)?

Yes = 67% No = 33%

Comments
The system came with exterior labels painted over = 3
(MANPRINT)

155. Are the procedures for operating AN/TRC-170 consistent with other microwave systems you have operated or been trained on?

Yes = 33% No =67%

No comment
(TR 3.1.9.1.1)

156. Are adequate prompts (cues) displayed when operator action is required?

Yes = 42% No = 58%

Comment
There are no meters or alarms which automatically indicate a gradual increase in BER.
(MANPRINT)

157. Is the labeling consistent with that on other systems you've used?

Yes = 33% No = 67%

Comment
Labels such as "up converter/down converter, supergroup, etc."
(TR 3.1.9.1.1)

158. Have you ever had problems because control actions are not consistent with what you are used to (in other systems, personal equipment, etc.)?

Yes = 0% No = 100%

No comment
(TR 3.1.9.1.1)

159. Are the groupings of controls with similar functions satisfactory? They should be grouped together so that performing an operation is made as easy as possible.

Yes = 58% No = 42%

Comment
Controls are easily changed with ungloved hands, question use of gloves.

160. Are there any other control or switch problems you have encountered? For example, size for your fingers--can you push the buttons? Your recommendations for solutions would be appreciated.

Yes = 25% No = 75%

Comments
The switches on LGM 1&2, TGM, GM are all hard to get to. = 2
The HPA reset button.
(MANPRINT)

161. Are the fault isolation and repair flowcharts correct?

Yes = 25% No = 75%

Comments

Flowcharts are not always adequate. We need to establish unit command emphasis to document problems as they are noted, because of large number of problems, correcting errors is cost effective

(TR 3.1.2.1.3)

162. Are there any other problems you are aware of about the TMs? Your recommendations would be appreciated.

Yes = 25% No = 75%

Comments

We need an operator summary TM.
We need Army written TMs.

(TR 3.1.4.6)

163. Overall, are AN/TRC-170 parts easy to remove, repair, and replace?

Yes = 50% No = 50%

Comments

The Klystron is a problem = 6
The size of the V3 = 2

(TR 3.1.3.1.3)

164. Does the arrangement of major components in the V2 shelter (amplifiers, power supplies, patch panels, LGM, TGM, etc.) make them easy to set up, monitor, and service?

Yes = 67% No = 33%

Comments

Everything good except the Klystron.

(TR 3.1.1.1.10)

165. Does the arrangement of major components in the V3 shelter (amplifiers, power supplies, patch panels, LGM, TGM, etc.) make them easy to set up, monitor, and service?

Yes = 42% No = 58%

Comments

The V3 is too small = 8
(TR 3.1.1.1.10)

166. Are there any parts of the site and antenna set-up for the V2 antenna system that are difficult in terms of time and effort needed to accomplish the tasks?

Yes = 92% No = 8%

Comments

The erection/disassembly of the LPA = 2
The assembly of the AZ-EL hub on the antenna = 1
The positioning of the mobilizer = 3
The drilling and setting of anchors for antenna = 6
The erection/disassembly of antenna = 3
(TR 3.1.6.1.3)

167. Are there any parts of the site and antenna set-up for the V3 antenna system that are difficult in terms of time and effort needed to accomplish the tasks?

Yes = 50% No = 50%

Comments

The erection/disassembly of the LPA = 2
The drilling and setting of anchors for antenna = 4
(TR 3.1.5.1.3)

168. Is the TM sufficiently small and rugged that it can be carried and stowed under operational conditions with a minimum of difficulty or damage (lost pages, etc.)?

Yes = 0% No = 100%

Comments

The manuals are too thick, should be placed in hard-cover three ring binder with reinforce on each page to reduce the chances that pages do not get torn out. = 3

The manual needs to be small with an operations summary. = 2

(TR 3.1.2.1.1)

169. Are any changes required or do you have any recommendations for changes to the logistics support concept or procedures that would increase tactical mobility?

Yes = 58% No = 42%

Comments

The V3 should be the prime system	= 1
The risk kits should be part of each shelter	= 3
The spares should include more anchors antenna pins	= 1
We should switch to operator/maintainer concept	= 6
The V2 should get rid of M720 mobilizer	= 1
A different antenna for the V2	= 1

(TR 3.1.3.1.9)

170. Do you have any further recommendations for change to the proposed logistics and maintenance concept?

Yes = 25% No = 75%

Comments

Improve the maintenance training system = 3

(TR 3.1.3.1.9)

171. Do you feel there should be more classroom training?

Yes = 75% No = 25%

Comments

The operators need much more practical hands on training. = 6

There should be more systems training (link engineering) = 2

(TR 3.1.6.1.5 & MANPRINT)

172. Do you feel there should be more collective (unit) training?

Yes = 92% No = 8%

Comments

There should be less emphasis on the 'looking good' such as uniform and barracks apperance (grass cutting) and more on developing operational proficiency.

There should be more team training = 2

(TR 3.1.6.1.2)

173. Were the interface procedures between AN/TRC-170 and other units satisfactory?

Yes = 33% No = 67%

Comments

We had to rely on Mitre interface document, Army dosen't understand it yet.

(TR 3.1.8.1.1)

174. Were the COMSEC procedures between AN/TRC-170 and other units satisfactory?

Yes = 50% No = 50%

There seemed to be many problems for which clearly outlined procedures were not developed.

(MANPRINT)

175. Was the compatibility/interoperability between the AN/TRC-170 and other communications equipment acceptable in terms of circuit quality, ease of cable and connector use, cable length, doctrine and procedures?

Yes = 58% No = 42%

Comments

The 26 pair hook-up a problem.

Everything except doctrine.

(TR 3.1.8.1.1)

176. Were the mission planning procedures adequate?

Yes = 58% No = 42%

Comments

There were not enough section chiefs/team chiefs or platoon sargents, we were short E-5's, E-6's and E-7's. = 2

(TR 3.1.6)

177. Have you observed or are you aware of ARTEP tasks degraded or not completed in a training environment due to safety or health considerations related to the operation of AN/TRC-170 vehicles and equipment?

Yes = 25% No = 75%

Comments

When we at keesler did not train on several tasks, one which is concerned w/system safety is the raising and lowering of the v2 antenna.

(TR 3.1.6)

UNIT INTERVIEW

All references to questions in this interview give the question number preceeded by the letter "D".

Respondant Demographics:

Rank:	E-5 = 1	O1 = 2	Age:	Average = 33.1	MOS	25A = 4	26V = 1
	E-6 = 1	O2 = 1				25c = 1	29W = 1
	E-7 = 5	O3 = 1				26Q = 2	31Z = 3
	WO2 = 1	O4 = 1				290A = 1	

Average time in MOS = 7.4 years

Average years in the Military = 12.7 years

Average years of civilian education = 14.5 years

Average months of military schools = 16.2 months

Average number of schools attended = 6

Do you believe that with the training and experience the operators and maintainers have had to date that they are SQT-qualified on the following operations and maintenance - related tasks? Use N/A only if you have not observed the task during the test.

Percentage of Yes and No responses

	Yes	No
1. Configuring the system with assignment sheet.....	100	0
2. Calibrating/Adjusting the Shelter Components.....	85	15
3. Recognizing faults during configuration set-up...	85	15
4. Fault diagnosis using BITE.....	85	15
5. Fault isolation using the flow charts.....	77	23
6. Fault diagnosis without BITE.....	38	62
7. Conducting Performance Test Checks.....	92	8
8. Performing PMCS.....	92	8
9. Removing/Replacing Shelter Components.....	62	38
10. Site Layout.....	85	15
11. 9.5 ft. Antenna Assembly.....	92	8
12. 9.5 ft. Antenna Disassembly.....	92	8
13. QRA Antenna Assembly.....	92	8
14. QRA Antenna Assembly.....	92	8
15. Antenna Adjustment and alignment.....	77	23
16. LPA Assembly/Erection.....	92	8

Comments:
General comment made that operators need more training
Q6 Some operators are able, but most do not fault isolate very well.
Q10 operators need more training on this.
Q15 need more training on link engineering.
(TR 3.1.1.1.18)

Can any three persons who can hold the 26Q MOS and proper skill identifier perform the following tasks? (The issue here is size and physical strength)

Percentage of Yes and No responses

	Yes	No
17. Erection of the LPA.....	23	77
18. Disassemble the LPA.....	31	69
19. Unload the low profile pallet.....	38	62
20. Erect the 9 1/2 Ft. antenna.....	23	77
21. Disassemble the 9 1/2 Ft. antenna.....	46	54
22. Maneuver the V2 shelter into position... (Assuming use of the mobilizer alone)	0	100
23. Maneuver the QRA into position.....	46	54
24. Install a complete set of anchors..... (Assumes 22 stakes and a time limit)	31	69
25. Get TRC-170 V2 operational in 5 hours...	31	69

Q19 do not think a small person would hold up to this task.
Q19-25 need more people for these tasks.
Q25 not if soil conditions are hard or rocky.
(TR 3.1.4.1.1)

26. Did the crew size used in the test provide enough people during tactical situations to accomplish all other tasks required to operate and maintain the AN/TRC-170 V2 and/or the V3?
YES = 0 NO = 100

Comments:

The crews should be increased to at least four persons	= 3
Addition to crew should be 29M (maintainer)	= 1
The crew size must be increased if they are going to be effective	= 1

(TR 3.1.4.1.1)

27. In your opinion are the anchors (duckbills) used for the 9 and 1/2 foot antenna and the LPA an effective system for the AN/TRC-170 in tactical circumstances?

YES = 15 NO = 85

Comments:

The present anchors take too long to install	= 4
Pionjar is too noisy for tactical environment	= 1
We need to supply a variety of anchors (rock, arrowhead)	= 5
Anchors need to be retriviable	= 5
We need to supply more anchors to each unit	= 1

(HF)

28. Have the correct MOS's been selected and assigned to operate and maintain the AN/TRC-170 V2 and V3?

YES = 92 NO = 8

Comments:

Army should consider operator/maintainer concept	= 3

(TR 3.1.4.1.1)

Are the operators able to perform the following tasks well enough to pass an SQT?

	Yes	No
29. Azimuth determination.....	85	15
30. Properly position antenna on the site...	100	0
31. Adjust Klystron.....	92	8
32. Generator operation/PMCS.....	100	0
33. Tactical set up of a tropo-radio site...	38	62
34. Understand/Use Crew Assignment Sheet....	85	15

Comments:

Q31-34 operators need more training = 2
Q33 Senior NCOs should do this = 1
(TR 3.1.4.1.2)

35. In your opinion should the location of items on the low profile pallet or in the shelter be changed? For example move the accessory kit to the shelter or truck?

YES = 69 NO = 31

Comments:

There should be allowance for HF radio in the van.
Perhaps van should go on truck and pallet on mobilizer.
(HF)

36. Do you believe that special physical or mental abilities over and above those currently required for 26QD6 or 29M MOS are necessary to operate and maintain the AN/TRC-170?

YES = 69 NO = 31

Comments:

Operators should be given a test of physical ability = 3
The GT score requirements should be raised = 1
The operators need at least two years field experience before they get the D6 training = 1
(TR 3.1.4.1.4)

37. Have you observed any training problems which you feel are important?

YES = 38 NO = 62

Comments:

Operators need more training on patching/patch panel use = 2
There was a lack of training on Pionjar, antenna alignment, PMCS, and crew assignment sheet. = 3
(TR 3.1.6.1.2)

38. Are the AN/TRC-170 V2 and V3 shelters, equipment, antennas, and support equipment rugged enough to withstand continued field use?

YES = 38 NO = 62

Comments:

The mobilizers are a problem (not rugged enough) = 9
The V2 antenna is not rugged enough = 3
V3 needs a better prime mover = 1
Shelters need to be more rugged = 1
(TR 3.1.7.1.1)

In your opinion, how many persons are required to perform the following setup and teardown tasks safely and efficiently on the AN/TRC-170 V2 or V3?

Tasks	Average Response Persons Required
39. LPA erection.....	3.2
40. LPA lowering.....	3.3
41. 9 & 1/2 ft. antenna erection....	3.7
42. 9 & 1/2 ft. antenna lowering....	3.7
43. Load/unload low profile pallet..	3.2
44. Position V2 mobilizer/shelter...	4.8
45. Set anchors with Pionjar.....	2.8
46. QRA Assembly/Disassembly.....	2.9
47. Position/set up 10kw generators.	2.2
48. Position QRA trailer.....	2.8

Comments:

No comments
(TR 3.1.7.1.7)

49. Do you feel the amount of training given was adequate considering the backgrounds and skill levels of the operators/maintainers?

YES = 62 NO = 38

Comments:
Operators need training in end-to-end troubleshooting.
Operators need more basic maintenance training.
(HF)

50. Does the arrangement of major components in the V2 shelter (amplifiers, power supplies, patch panels, LGM, TGM, etc.) make them easy to set up, monitor, and service?

YES = 54 NO = 46

Comments:
The shelter weight distribution is bad = 4
There needs to be provision for an HF radio = 1
(HF)

51. Does the arrangement of major components in the V3 shelter (amplifiers, power supplies, patch panels, LGM, TGM, etc.) make them easy to set up, monitor, and service?

YES = 69 NO = 31

Comments:
The shelter work area is too small = 3
(HF)

52. In your opinion should the AN/TRC-170(V2) continue to use the current mobilizer as its prime mode of transportation?

YES = 0 NO = 100

Comments

Put V2 on heavy duty mobilizer (M832) = 3
Put V2 on truck (5-ton) = 4
(TR 3.1.7.1.1)

53. In your opinion is the supply allocations and procedures for AN/TRC-170 compatible with the existing Army Supply System?

YES = 31 NO = 69

Comments:

The An/TRC-170 is not yet in the Army supply system = 7
Need more risk kits in the field = 4
Pionjar supplies and fuel are a problem = 2
Anchors are a supply problem = 1
(TR 3.1.4.2)

54. Are the current numbers of 26Q operators & 29M maintenance personnel adequate for effective mission performance on the AN/TRC-170?

YES = 8 NO = 92

Comments:

We need at least four person teams = 4
A 29M should be added to each team = 7
(TR 3.1.4.3)

55. Are the common and special tools which are supplied with AN/TRC-170 equipment adequate for effective mission performance?

YES = 38 NO = 62

What tools are not supplied that are required?

Rubber mallet	= 1
Fuels can for Pionjars	= 1
Shovels, picks	= 1
Pionjar accessories	= 1
Lantern & shop light	= 1

(TR 3.1.3.1.2)

56. Should any items be added to or deleted from the PLL or ASL? (Proposed Load List - Authorized Supply List)

YES = 46 NO = 54

Comments:

Need more risk kits	= 5
Need breakers in risk kits	= 1

(TR 3.1.3.1.12)

57. Do you feel there should be more collective (unit) training? (training by the unit at Ft. Huachuca)

YES = 69 NO = 31

Comments:

Training needs to be conducted weekly at a minimum	= 2
Training should be once or twice a month	= 2

(TR 3.1.6.1.2)

58. Do you think that unit personnel (not 26Q) should have received training on the AN/TRC-170 system?

YES = 77 NO = 23

Comments:

Unit people should receive training on new systems	= 4

(TR 3.1.6.1.2)

59. Do you think that planning personnel (G3) should have received training on the AN/TRC-170 system?

YES = 92 NO = 8

Comments:

A familiarization course should be provided = 5
(TR 3.1.6.1.2)

60. If you could change anything on the AN/TRC-170 or in the training supplied with it, would you?

YES = 69 NO = 31

Comments:

Replace the mobilizer	= 4
Change waveguide hookups to side of the van	= 1
New V2 antenna (truck mounted)	= 4
Change anchor system	= 1
Replace 10kw generators with 15kw	= 2
Need ECU in each shelter	= 1
Replace LPA	= 1

(TR 3.1.6.1.2)

61. In your opinion should current operation/Maintenance doctrine be changed? (i.e. let operators do the basic component change tasks?)

YES = 100 NO = 0

Comments:

Operators should be given more maintenance responsibilities = 4
(TR 3.1.1.1.18)

DATA COLLECTORS INTERVIEW

All references to questions in this interview give the question nu
preceeded by the letter "D".

Respondant Demographics:

MOS: 26Q = 2; 26V = 15; 29M = 1; 31C = 4; 31E = 1; 31K = 1;
31M = 2; 31V = 1; 32Z = 2; 36C = 2; 72G = 4.

Average age: = 26.1 years

Average years in MOS: = 5.1 years

Average years of military service: = 7.1 years

Average years of civilian education: = 12.7 years

Average months of military education: = 4.8 months

Average number of schools attended: = 3

Did you observe any difficulties with the operation, removal, repair, or replacement of the following items on the AN/TRC-170?

	Response percentages	Yes	No
1.	RF Amplifier	3	97
2.	Control Logic Assembly	6	94
3.	Control Logic Assembly Circuit Cards	14	86
4.	High Voltage Power Supply	20	80
5.	Fast Interrupt (FAINT) Assembly	14	86
6.	Inverters	0	100
7.	RF Protect and Metering	8	92
8.	Klystron	23	77
9.	Amplifier Up-converter Assembly	3	97
10.	Downconverter Assembly	3	97
11.	Dual RF Synthesizer	11	89
12.	Tropo Modem Modulator	6	94
13.	Tropo Modem Demodulator	0	100
14.	TED 1 and 2	54	46
15.	COMSEC gear in general	51	49
16.	Low Voltage Power Supply	0	100
17.	Baseband Patch Panel	0	100
18.	Loop Group Multiplexer (LGM-1)	11	89
19.	Group Modem	11	89
20.	Trunk Group Multiplexer	11	89
21.	LGM-2/LSCDM	6	94
22.	Ac to Ac Converter	9	91
23.	V2 mobilizer	74	26
24.	Alarm Monitor	3	97
25.	Orderwire Control Unit	29	71
26.	IF Test Panel	0	100
27.	Heater Assembly	20	80
28.	Analog Voice Orderwire Unit	3	97
29.	Noise Source	0	100
30.	Flushing Fan	3	97
31.	Remote Orderwire Control Unit (ROCU)	14	86
32.	LED Matrix Circuit card assembly	3	97
33.	Heat Sensor Warning Switch	0	100
34.	Centrifugal Fan	0	100
35.	Tube axial Fans (specify)	3	97
36.	Vane axial Fan	0	100

Comments:

See next page for comments

Comments

Q01	waveguide a problem for this unit	=	1
Q02	remove and replace a problem	=	1
Q03	kept having to reseat cards after moves	=	4
Q04	false alarms	=	3
Q05	generator operation caused power to trip (blew fuses)	=	6
Q08	overheating and power surges are problems	=	7
Q11	had to be repaired twice during the test	=	2
Q14	problem loading variables (operator training)	=	11
Q15	operators need more COMSEC training	=	9
Q16	operator made errors in using	=	1
Q17	connector behind panel broken	=	1
Q18	operator mis-patched into this unit	=	1
Q19	A13 & A14 cards false fault lights (reseated often)	=	2
Q21	had to reseat cards after moves	=	1
Q23	mobilizer wheel and axle problems (not rugged enough)	=	12
Q25	orderwire kept locking up	=	2
Q27	heater does not work very well	=	3
Q30	rain leaked through fan assembly	=	1

(TR 3.1.1.1.10)

37. Were there any situations during equipment diagnosis, repair or checkout that BITE was used but it was not designed to detect?

Yes = 29% No = 71%

Comments

BITE did not detect problem in synthesiser = 5
BITE worked operator did not pay attention = 1
(TR 3.1.1.1.15e)

38. Were there any situations during equipment diagnosis, repair or checkout when BITE was not used but it should have been?

Yes = 26% NO = 74%

Comments

The operators ignored or did not see fault lights = 7
(TR 3.1.1.1.15f)

39. Were adequate alternative diagnostic procedures available when BITE/TMDE was not?

Yes = 69% No = 31%

Comments

The flowcharts were not accurate = 3
There was no test equipment in vans = 2
The operators did no maintenance = 2
(TR 3.1.1.1.15f)

40. Overall, were equipment failures easy to recognize during configuration, set-up, and operation?

Yes = 86% No = 14%

Comments

Operators had problems with end-to-end trobleshooting = 4
We had a TEDs problem due to bent pins (hard to find) = 1
(TR 3.1.1.1.16)

Do you believe that with the training and experience the operators and maintainers have had to date that they are SQT-qualified on the following operations and maintenance - related tasks? Use N/A only if you have not observed the task during the test.

Response percentages	Yes	No
41. Configuring the system with assignment sheet.....	94	6
42. Calibrating/Adjusting the Shelter Components.....	94	6
43. Recognizing faults during configuration set-up...	86	14
44. Fault diagnosis using BITE.....	71	29
45. Fault isolation using the flow charts.....	51	49
46. Fault diagnosis without BITE.....	49	51
47. Conducting Performance Test Checks.....	94	6
48. Performing PMCS.....	91	9
49. Removing/Replacing Shelter Components.....	69	31
50. Site Layout.....	83	17
51. 9.5 ft. Antenna Assembly.....	94	6
52. 9.5 ft. Antenna Disassembly.....	94	6
53. QRA Antenna Assembly.....	89	11
54. QRA Antenna Assembly.....	86	14
55. Antenna Adjustment and alignment.....	91	9
56. LPA Assembly/Erection.....	94	6

Comments:

Comments

Q44 operators need more experience trouble shooting = 4
Q45 operators need more experience and training = 5
Q46 operators need more experience in trobleshooting = 5
Q49 operators need more taining to do these tasks = 3
Q50 operators need more training = 3
Q55 antenna alignment meter has never worked correctly = 2

Can any three persons who can hold the 26Q MOS and proper skill identifier perform the following tasks? (The issue here is size and physical strength)

Response percentages	Yes	No
57. Erection of the LPA.....	14	86
58. Disassemble the LPA.....	20	80
59. Unload the low profile pallet.....	57	43
60. Erect the 9 1/2 Ft. antenna.....	49	51
61. Disassemble the 9 1/2 Ft. antenna.....	54	46
62. Maneuver the V2 shelter into position... (Assuming use of the mobilizer alone)	3	97
63. Maneuver the QRA into position.....	60	40
64. Install a complete set of ground stakes. (Assumes 22 stakes and a time limit)	77	23
65. Get TRC-170 V2 operational in 5 hours...	54	46

Comments:

Q57-58 can be done, but unsafe with less than four people = 11
Q59 fatigue a problem (also shift schedule) = 4
Q60-61 need at least one tall person or a ladder (4 people) = 6
Q62 really need a truck, should not be moved by hand = 6
Q63 on level ground, but not on a hill safely = 2
(TR 3.1.4.1.1)

66. Did the crew size used in the test provide enough people during tactical situations to accomplish all other tasks required to operate and maintain the AN/TRC-170 V2 and/or the V3?

Yes = 37% No = 63%

Comments

The tactical requirements need 4 to 6 person crews = 10
(TR 3.1.4.1.1)

67. In your opinion are the anchors (duckbills) used for the 9 and 1/2 foot antenna and the LPA an effective system for the AN/TRC-170 in tactical circumstances?

Yes = 63% No = 37%

Comments

We need smaller size anchor for hard ground	=	9
We need rock anchors	=	1
We need a variety of anchors for different conditions	=	1
We need an achor that can be reused (too expensive)	=	5
Anchors tell enemy direction of shot and unit type	=	1
The current anchors take too long to emplace	=	3
Current anchor pulls out if ground is soft	=	2

(MANPRINT)

68. Have the correct MOS's been selected and assigned to operate and maintain the AN/TRC-170 V2 and V3?

Yes = 86% No = 14%

Comments

The operator/maintainer function should be combined	=	8

(TR 3.1.4.1.1)

Are the operators able to perform the following tasks well enough to pass an SQT?

Response percentages	Yes	No
69. Azimuth determination.....	83	17
70. Properly position antenna on the site....	89	11
71. Adjust Klystron.....	91	9
72. Generator operation/PMCS.....	86	14
73. Tactical set up of a tropo-radio site....	60	40
74. Understand/Use Crew Assignment Sheet.....	94	6

Comments:

Q69 operators need more training on this task	=	5
Q70 operators need more training on this task	=	1
Q73 this task is a skill level 2 task	=	4

(TR 3.1.4.1.2)

Are the maintainers able to perform the following remove and replace tasks well enough to pass an SQT?

Response percentages	Yes	No
75. RF Amplifier	31	69
76. Control Logic Assembly	49	51
77. Control Logic Assembly Circuit Cards	66	34
78. High Voltage Power Supply	60	40
79. Fast Interrupt (FAINT) Assembly	43	57
80. Inverters	49	51
81. RF Protect and Metering	51	49
82. Klystron	54	46
83. Amplifier up-converter Assembly	54	46
84. Downconverter Assembly	54	46
85. Dual RF Synthesizer	60	40
86. Tropo Modem Modulator	51	49
87. Tropo Modem Demodulator	49	51
88. TED 1 and 2	60	40
89. COMSEC gear in general	57	43
90. Low Voltage Power Supply	57	43
91. Loop Group Multiplexer (LGM-1)	51	49
92. Group Modem	54	46
93. Trunk Group Multiplexer	49	51
94. LGM-2/LSCDM	49	51
95. Ac to Ac Converter	60	40
96. Shelter internal cabling	14	86
97. Alarm Monitor	49	51
98. Orderwire Control Unit	54	46
99. IF Test Panel	54	46
100. Noise Source	51	49
101. Flushing Fan	49	51
102. Remote Orderwire Control Unit (ROCU)	54	46
103. LED Matrix Circuit card assembly	49	51

Record#	Q104	Q105	Q106	Q107
	17	17	18	17

104. Heat Sensor Warning Switch	49	51
105. Centrifugal Fan	49	51
106. Tube axial Fans (specify)	51	49
107. Vane axial Fan	49	51

Comments:

The problem is troubleshooting not R & R	=	4
Q82 this task is very slow and time consuming	=	1
Q96 this should be done at depot level	=	2

(TR 3.1.4.1.2 & 3.1.1.1.10)

108. In your opinion should the location of items on the low profile pallet or in the shelter be changed? For example move the accessory kit to the shelter or truck?

Yes = 54% No 46%

Comments

Pionjar should not be carried in the van	= 1
Accessary kit should be moved off the pallet	= 5

(MANPRINT)

109. Do you believe that special physical or mental abilities over and above those already specified are required to operate and maintain the AN/TRC-170?

Yes = 20% No = 80%

Comments

Given present crew size we need larger people	= 9
We need larger crew size	= 1

(TR 3.1.4.1.4)

110. Have you observed any training problems which you feel are important?

Yes = 51% No = 49%

Comments

Operators need COMSEC training	= 1
Operators need training on generator PMCS	= 2
Operators need vehicle PMCS training	= 2
Operators need troubleshooting training	= 1
Operators need site set up and layout training	= 2
More hands on training should be provided	= 6
Operators need training in Army procedures	= 4
Pionjar training is needed	= 1

(TR 3.1.6.1.2)

111. Are the AN/TRC-170 V2 and V3 shelters, equipment, antennas, and support equipment rugged enough to withstand continued field use?

Yes = 46% No = 54%

Comments

The mobilizer is a problem	=	13
The pins for the antennas	=	7
The V2 antenna	=	5
The LPA	=	4

(TR 3.1.7.1.1)

112. Did you have any problems reaching any of the sites used in the test due to lack of mobility of the AN/TRC-170 equipment?

Yes = 31% No = 69%

Comments

The mobilizer is not rugged enough	=	9
The weight and balance of the V2 van	=	4
The 2.5 ton truck is underpowered for the job	=	3

(TR 3.1.7.1.2)

In your opinion, how many persons are required to perform the following setup and teardown tasks safely and efficiently on the AN/TRC-170 V2?

Tasks	average	Persons Required
113.	LPA erection.....	4.0
114.	LPA lowering.....	3.9
115.	9 & 1/2 ft. antenna erection....	3.5
116.	9 & 1/2 ft. antenna lowering....	3.4
117.	Load/unload low profile pallet..	3.5
118.	Position V2 mobilizer/shelter...	5.2
119.	Set anchors with Pionjar.....	2.5

Comments:

Q117 need four to do it safely	=	2
Q118 need more than six people for task	=	1
Q119 depends on soil type of site	=	1

(TR 3.1.7.1.7)

In your opinion, how many persons are required to perform the following setup and teardown tasks safely and efficiently on the AN/TRC-170 V3?

Tasks	average	Persons Required
120.	LPA erection.....	3.7
121.	LPA lowering.....	3.6
122.	QRA assembly.....	2.5
123.	QRA disassembly.....	2.5
124.	Position/set up 10kw generators.	1.9
125.	Position QRA trailer.....	2.5
126.	Set anchors with Pionjar.....	2.1

Comment

Q125 setting trailer legs a problem in rough terrain.
(TR 3.1.7.1.7)

127. Did you observe any problems during set-up and teardown of the AN/TRC-170 V2 and/or the V3?

Yes = 49% No = 51%

Comments

Night setup/tear down is unsafe	=	2
The hub alignment of the AZ-EL assembly on V2	=	1
The antenna pins	=	2
The waveguide connection to shelter and antenna	=	1
The feedhorn container (inserting feedhorn)	=	1
The erection of the LPA	=	4
The use of the Pionjar (anchor system)	=	4
The manual positioning of the V2 while it is on mobilizer	=	5

(TR 3.1.7.1.9)

128. Have you observed any situations where the operator or maintainer had to reach or climb in a manner that was not safe? (For example they should of had a ladder).

Yes = 69% No = 31%

Comments

The installation of pedals on the V2 antenna	=	2
The putting up of camoflage	=	9
Install and/or adjust the waveguides	=	5

(MANPRINT)

129. In your opinion are there any items of environment such as illumination, noise, ventilation, temperature, vibration, and climate that pose a potential problem for AN/TRC-170 operators?

Yes = 77% No = 23%

Comments

The noise in the van is a problem = 15
The heat/cold in van, need an ECU = 14
The interior lights need to be brighter = 2
(MANPRINT)

130. In your opinion could personnel effectively perform maintenance functions in MOPP 2 gear?

Yes = 91% No = 9%

131. In your opinion could personnel effectively perform maintenance functions in MOPP 4 gear?

Yes = 29% No = 71%

Comments

The MOPP IV situation will increase time and difficulty of the task = 6
The task can not be performed safely in MOPP IV gear = 3
The V3 is too small to wear MOPP gear = 1
(MANPRINT)

132. Have you observed any physical interface problems with AN/TRC-170? (i.e. cables, waveguide, etc.)

Yes 49% No = 51%

Comments

The waveguide alignment pins and latchs = 14
The generator cable hookup for the V3 = 4
The TEDs do not fit correctly = 1
(TR 3.1.8.1.6)

SAFETY

Have you or others observed potential or actual safety hazards that could result in shock, burns, falls, cuts, bruises, explosions, entanglements in moving parts, strains due to lifting or handling, or other injuries? Please consider all situations when the equipment will be operated: at night; with MOPP gear; in rain or snow; in heat, etc. Also consider all aspects of the equipments' operation: movement from site to site; site setup; preparations for mission; actual mission operation, and site breakdown.

Response percentages	Yes	No
9.5 ft. Antenna		
133. Reflector Hub	9	91
134. Reflector Petals	3	97
135. Rear Strut	20	80
136. Az-El Assembly	9	91
137. Legs	3	97
138. Feedhorn and Struts	0	100
139. Cables and winch	11	89
140. Base Plates and Tension Towers	11	89
141. Waveguide/Messenger Cable	6	94
142. Other	6	94
Quick Reaction Antenna		
143. Extension Tubes	3	97
144. Trailer	3	97
145. Reflector Petals	3	97
146. Reflector Hub	3	97
147. Az-El Assembly	0	100
148. Antenna Hoist Assembly	3	97
149. Waveguide/Messenger Cable	6	94
150. Pionjar Driver/Accessories	43	57
151. Lightning Protection Assembly	57	53
152. Ground Support Equipment (generators)	11	89
V2/V3 Shelter		
153. Power and Cable Connections(Internal)	3	97
154. Power and Cable Connections(External)	3	97
155. Power Supplies	6	94
156. Amplifiers	0	100
157. Converters	0	100
158. Other Components	0	100

Comments:

General: operator do not wear safety gear	= 9
Q133 hub is heavy and it is easy to pinch fingers	= 3
Q140 the skid in process for antenna erection	= 5
Q142 adjusting AZ-EL before antenna is fully erected	= 1
Q144 climbing onto trailer before legs are set	= 1
Q150 need to stand on something to get Pionjar started	= 3
Q150 Pionjar is loud (noise safety)	= 2
Q151 LPA baseplate needs redesign	= 12
Q158 V3 headroom a problem (MANPRINT)	= 1

159. Have you or others received any injuries during the conduct of this test while operating or maintaining AN/TRC-170 equipment? Please describe what you were working on and what caused the injury.

Yes = 29% No = 71%

Comments

Reported minor cuts, abrasions, etc.	=	3
Reported broken hand (finger)	=	5
Reported wrist or shoulder sprain	=	2

(MANPRINT)

160. Do the location and size of the fault indicator lights make it easy to see when they are "on"?

Yes = 86% No = 14%

Comments

The HPA lights are hard to see with the door open (glare)	=	4
The lights need to be larger to be seen easily	=	3
Some of the faults are too low to be seen easily	=	1

(MANPRINT)

161. Are the display dials readable and understandable?

Yes 94% No = 6%

Comments

The BER meter is too small to read	=	3

(MANPRINT)

162. Are all labels easy to read and understand (inside the shelter, outside the shelter, on antenna equipment, etc)?

Yes = 97% No = 3%

Comments

The Pionjar labeling is not secured (labels falling off)	=	1
The labels on the Pionjar are hard to read	=	1
The units came with markings and labels painted over	=	3

(MANPRINT)

163. Do you feel the amount of training given was adequate considering the backgrounds and skill levels of the operators/maintainers?

Yes = 83% No = 17%

Comments

Operators need more practical (hands-on) training	= 8
Maintainers need troubleshooting training	= 3
Operators need more "system" training	= 2
Operators need COMSEC training	= 2

164. Does the arrangement of major components in the V2 shelter (amplifiers, power supplies, patch panels, LGM, TGM, etc.) make them easy to set up, monitor, and service?

Yes = 77% No = 23%

Comments

The weight/balance needs to be improved	= 5
There needs to be an HF radio in the van	= 2
There needs to be a work surface (table) in the van	= 1

(MANPRINT)

165. Does the arrangement of major components in the V3 shelter (amplifiers, power supplies, patch panels, LGM, TGM, etc.) make them easy to set up, monitor, and service?

Yes = 43% No = 57%

Comments

The work area in the V3 is too small	= 17
Maintenance access a problem	= 2

(MANPRINT)

166. Are there any parts of the site and antenna set-up for the V2 antenna system that are difficult in terms of time and effort needed to accomplish the tasks?

Yes = 51% No = 49%

Comments

Pionjar operation in hard ground (anchors supplied)	= 11
LPA erection	= 3
Erection of the V2 antenna	= 6

(TR 3.1.7.1.9)

167. Are there any parts of the site and antenna set-up for the V3 antenna system that are difficult in terms of time and effort needed to accomplish the tasks?

Yes 23% No = 77%

Comments

LPA erection	= 4
The duckbill anchors	= 4
Cranking up the QRA	= 3

(TR 3.1.7.1.9)

168. In your opinion should the AN/TRC-170(V2) continue to use the current mobilizer as its prime mode of transportation?

Yes = 9% No = 91%

Comments

The shelter should be mounted on a five ton truck	= 23
The shelter should be mounted on a heavy duty mobilizer	= 5

(TR 3.1.7.1.1)

APPENDIX C

Results of Operator and Maintainter
Interviews on Training

The data in the following tables is presented as supporting information for the training evaluation. The structured interview was given to operators and maintainers in October 1986 at the beginning of test phase III.

TABLE 1

Major Topics Covered in Block 1 of Keesler AN/TRC-170 Army Operator Course, Training Materials and Procedure Used, and Evaluation Oriented Comments

TOPICS COVERED	TRAINING MATERIALS/ PROCEDURES	EVALUATIVE COMMENTS
Orientation	/lecture	
Fraud, Waste & Abuse Program	SHO KEP HO 18/ lecture	
Safety & Security	T031R2-2 TRC 170-1-1/lecture	1. Training relevant to field operations. Good initial focus on the need for safety concerns around equipment.
Training Evaluation Feedback System	SHO KAU 1165/ lecture	
Student Critique Program	ATCR 52-29/ lecture	
AN/TRC-170 Capabilities	KCS-4411/lecture SHO KCS 6406A/ Discussion/Student Participation	2. Requiring Class participation to fill in the charts on pages 1, 5, 6 of KCS 4411 provided good orientation to systems characteristics. Training materials were easy to use and made possible the acquisition of factural information about the system.

TABLE 1 (cont.)

TOPICS COVERED	TRAINING MATERIALS/ PROCEDURES	EVALUATIVE COMMENTS
System Functional Block Program Analysis	KCS 4411/lecture KCS 6412/ Discussion/Student Participation	3. Good introduction to an important topic. Talking through diagrams in Figs 1, 3-5 of KCS 6412 would have been helpful; discussion of pages 15-17 of the AC Power Distribution Diagram was of minimal value.
Equipment Component Addresses (Bay/Level)	KCS-4411/lecture /laboratory /Student Participation	4. An extremely well taught subject providing a system orientation which facilitated subsequent training.
Turn-on Procedures	TO 31R2-2TRC-170-1-1/lecture P4-44, 4-45/ Discussion /Demonstration /Laboratory Exercise	5. Useful procedurally-oriented training clearly having relevance to field operation. Testing should have encouraged use of TO/TM to foster a habit of strict adherence to procedures. Two additions to published procedures were documented by instructor: 1) After step 1: "Check that vents are open" and 2) After step 11: "Shut phase select switch off".

TABLE 2

Major Topics Covered in Block 2 of Keesler AN/TRC-170 Army Operator Course, Training Materials and Procedure Used, and Evaluation Oriented Comments

TOPICS COVERED	TRAINING MATERIALS/ PROCEDURES	EVALUATIVE COMMENTS
Loop Group Multiplexer (LGM) panel Control Indicators, CCA (LRU) Controls/ Indicators/ Switches	KCS 6407A (pp 1-9 to 1-11, 1-14 to 1-17, 1-22 to 1-23)/lecture	1. Appropriate for orientation to equipment; however, switch setting adjustments need to be incorporated into a procedural sequence for operations training. Needed information for setting switches exists in training documentation; however, material is not procedurally-oriented or even organized to facilitate efficient learning. See sample training aid for Operators training in Appendix B, Table 10.
Simple System Functional Block Diagram (one LGM only)	/lecture	2. Good introduction to construction of system functional block diagrams given equipment to be used in system configuration--especially appropriate for G-3 level personnel who construct Crew Assignment Sheets.
Group Modem (GM)	C&D KCS 6412 (pp 10-12) /lecture	3. Discussion of Block Diagrams (modified signal flow) does <u>not</u> contain information which appears useful for operation. It appeared that these materials provided a vehicle for presenting information upon which factually oriented PC and Block test items could be constructed.

TABLE 2 (cont.)

TOPICS COVERED	TRAINING MATERIALS/ PROCEDURES	EVALUATIVE COMMENTS
Group Modem (GM) cont.	SG KCS 6407A (pp 2-28 to 2-29) /lecture	4. See comment #1 above.
Trunk Group Multiplexer	C&D KCS 6412 (p 14)/lecture	5. See comment #3 above.
	SG KCS 6407A (pp 3-16 to 3-18) /lecture	6. See comment #1 above.
More Complex Functional System Block Diagrams	/lecture	7. Discussed only basic principles of construction. Discussion of several examples would have been helpful. Understanding of Functional Block Diagrams in especially useful to guide in the wiring of the Baseband Patch Panel (BBPP) without a Crew Assignment Sheet.
	Workbook KCS 4412 (Service Test)	8. Contains several exercises on construction of Functional System Block Diagrams. Distribution and detailed discussions of prepared solutions after students attempts to complete exercises would be especially instructive.
Baseband Patch Panel (BBPP) wiring	/lecture	9. Used overhead projector to sketch principles of BBPP wiring. This is a task where student involvement--actually drawing lines on a BBPP picture or inserting wires into the BBPP-

TABLE 2 (cont.)

TOPICS COVERED	TRAINING MATERIALS/ PROCEDURES	EVALUATIVE COMMENTS
		for different specifications would have facilitated learning. BBPP sheets for practice were provided after class request.
Baseband Patch Panel (BBPP) wiring (cont.)	Workbook KCS 4412 (Service Test)	10. A solution booklet should have been passed out with opportunity for comparison to worked out solutions and instruction/discussion of errors.
Control Order Wire Unit (COU)	SG KCS 6417 (pp 3-3, 3-7, 3-16 C&D) KCS 6412 (p 16)/Instructed to read	11. Since this equipment is designed primarily to help the repair person maintain the cable systems, it is questionable whether Operators should receive this training. COU Functional Block Program was of minimal value. See comment #3 in Table for Block 2.
Ring Generator	SG KCS 6417 (p 3-17) /Instructed to read	12. No clear relevance to systems operations.
Remote Loop Group Multiplexer (RLGM)	SG KCS 6417 (pp 4-1, 4-2) /Instructed to read	13. Instruction on use were limited and not clearly documented. Appreciation for conditions when RLGM would be used were not well developed. Does appear to be a relevant piece of equipment for an Army communications system.
Remote Multiplex Combiner (RMC)	SG KCS 6417 (pp 5-1 & 5-2) /Instructed to read	14. See comment #13.

TABLE 2 (cont.)

TOPICS COVERED	TRAINING MATERIALS/ PROCEDURES	EVALUATIVE COMMENTS
Low Speed Cable Driver Modem (LSCDM)	SG KCS 6417 /Instructed to read	15. Good description of characteristics. See also comment #13.
	C&D KCS 6412 (p 15)	16. See comment #3.

TABLE 3

Major Topics Covered in Block 3 of Keesler AN/TRC-170 Army Operator Course, Training Materials and Procedure Used, and Evaluation Oriented Comments

TOPICS COVERED	TRAINING MATERIALS/ PROCEDURES	EVALUATIVE COMMENTS
Analog Voice Order Wire (AVOW)	KCS 6416 (p 1) /lecture	1. Providing drawing schematic colocated with index and description of parts facilitates an orientation to AVOW not found in the TM used by soldiers in the field.
AVOW Functional Block Diagram	KCS 6416 (p 2) /lecture	2. Diagram used as a basis for lecture; procedurally, information conveyed did not appear useful.
Digital Voice Order Wire (DVOW)	KCS 6416 (pp 5-8) /lecture	3. See comment #1 above, (for pp 5-6) also see comment #3 in Table for Block 2 (for p 7). Functional Block Diagram on p 8 was tied more to observable system components. Lecture utilizing this diagram was not procedural, however, it did provide useful orientation to system operation.
ROCU Self Test	PTO 31 R2-2TRC-170 -1 Combined Operations and Maintenance Instructions (pp 6-226 to 6-228)/Laboratory	4. Instructions were adequate and the practical exercise was operations (procedurally) oriented. Additional training on use for communicating between shelters would have been helpful.

TABLE 3 (cont.)

TOPICS COVERED	TRAINING MATERIALS/ PROCEDURES	EVALUATIVE COMMENTS
VOCU Self Test	PTO 31 R2-2TRC-170 -1 Combined Operations and Maintenance Instructions (pp 6-223 to 6-225)/Laboratory	5. See comment #4 above.
Data Order Wire (DOW) and Alarm Monitor	KCS 6416 (pp 18-21, 23) /lecture	6. See comment #1 above; for p 23 comment #3 in Table for Block 2 is applicable.
Remote Antenna Alignment Meter (RAAM)	/lecture /laboratory	7. Lecture provided orientation; however, laboratory hook-up provided only partial operational experience; utilization with raised antenna in a communicating system would have provided added useful experience and feedback on the appropriateness of procedures followed.
System Encryption Device Vinson, Trunk Encryption Device (TED) and Dedicated Loop Encryption Device (DLED)	KCS 6416 (pp 16-17) /lecture KAO 179A/TSEC/lab KAO 168B/TSEC/lab KAM 410B/TSEC/lab	8. Training was practical and procedurally-oriented for individual shelters; because materials used were mostly classified and preclude soldier review at will, additional periodic unit training should be programmed so that encryption related tasks are readily recalled in the field environment.

TABLE 4

Major Topics Covered in Block 4 of Keesler AN/TRC-170 Army Operator Course, Training Materials and Procedure Used, and Evaluation Oriented Comments

TOPICS COVERED	TRAINING MATERIALS/ PROCEDURES	EVALUATIVE COMMENTS
Tropo Modem Modulator: Controls and Indicators	C&D KCS 6414 (pp 1-2)/lecture	1. Composite of legend keyed to numbered parts in picture schematics, are both colocated in the training document. Provides a good orientation to Tropo Modem--something not currently found in TM.
Tropo Modem Transmit Signal	C&D KCS 6414 (p 3) /lecture	2. Diagram used as a basis for lecture; procedurally information conveyed did not appear useful to Operator. May have provided a basis for developing PC or Block Test items. C&D Booklets were constructed as triple length sheets which generally were inconvenient to work with.
Tropo Modem Timing	C&D KCS 6414 (p 4) /lecture	3. Diagram used as basis for lecture; discussion of different types of timing and its relationship to switch settings and Baseband Patch Panel wiring was useful knowledge and procedurally relevant. Training functional block diagrams provided little of value for Operators--discussion of different cards in Tropo Modem would be helpful to serve as resource information for Maintainers to use in troubleshooting.

TABLE 4 (cont.)

TOPICS COVERED	TRAINING MATERIALS/ PROCEDURES	EVALUATIVE COMMENTS
Tropo Modem Receive Signal	C&D KCS 6414 (p 8) /lecture	4. See comment #2 above.
Frequency Synthesizer: Controls and Indicators	C&D KCS 6414 (p 13)/lecture	5. See comment #1 above.
Frequency Synthesizer Block Diagram	C&D KCS 6414 (pp 15-17)/lecture	6. See comment #2 above.
Transmitter Amplifier Converter: Controls and Indicators	C&D KCS 6414 (p 19)/lecture	7. See comment #1 above.
Transmitter Amplifier-- Converter Block Diagram	C&D KCS 6414 (p 20)/lecture	8. See comment #2 above.
RF (HPA) Amplifier: Controls and Indicators	C&D KCS 6414 (pp 21-26)/lecture	9. See comment #1 above; instructor pointed out problem with Tropo toggle switch in BITE PANEL--when operating in LOS switch setting for ANT and DL are reversed; as a minimum, labeling for switch should indicate difference--would be better if internal wiring were changed so that UP indicated ANT, down DL regardless whether operating in Tropo or LOS.
RF Amplifier (1KW) Block Diagram	C&D KCS 6414 (pp 27-36)/lecture	10. See comment #2 above.

TABLE 4 (cont.)

TOPICS COVERED	TRAINING MATERIALS/ PROCEDURES	EVALUATIVE COMMENTS
Receiver Amplifier-- DOWN Converter: Control and Indicators	C&D KCS 6414 (p 37)/lecture	11. See comment #1 above.
Receiver Amplifier-- DOWN Converter Block Diagram	C&D KCS 6414 (p 38)/lecture	12. See comment #2 above.
IF Test Panel: Controls and Indicators	C&D KCS 6414 (p 39)/lecture	13. See comment #1 above.
IF Test Panel Block Diagram	C&D KCS 6414 (pp 41-42)/lecture	14. See comment #2 above.
Prime Power Application	TO 31R2-2TRC-170-1-1, Table 4-24 (pp 4-51 to 4-53) /Laboratory	15. Procedures good and hands-on experience procedurally relevant.
Frequency Synthesizer Tune-up	TO 31R2-2TRC-170-1-1, Table 4-24 (pp 4-58)/Laboratory	16. See comment #15.
Preliminary Set-up for Tropo Mode	TO 31R2-2TRC-170-1-1, Table 4-27 (pp 4-65 to 4-66) /Laboratory	17. Comment #15 generally applies; add to the end of step 8: "Verify serial number on chart and Klyston are the same".
Turn-on and Checkout for Tropo Mode	TO 31R2-2TRC-170-1-1, Table 4-28 (pp 4-67 to 4-69) /Laboratory	18. Comment #15 generally applies; add to end of step 15: "and RF OUTPUT-TROPO kilowatt meter should increase".

TABLE 4 (cont.)

TOPICS COVERED	TRAINING MATERIALS/ PROCEDURES	EVALUATIVE COMMENTS
LOS Mode Set-up	TO 31R2-2TRC-170-1-1, Table 4-29 (p 4-69)/Laboratory	19. See comment #15.
Gain Equalization	TO 31R2-2TRC-170-1-1, Table 4-26 (pp 4-63 to 4-64) /Laboratory	20. Comment #15 generally applies; add after step 9: "NOTE: if adjustment cannot be made to midscale for any channel, perform adjustment to lowest channel value that is obtained for all."

TABLE 5

Major Topics Covered in Block 5 of Keesler AN/TRC-170 Army Operator Course, Training Materials and Procedure Used, and Evaluation Oriented Comments

TOPICS COVERED	TRAINING MATERIALS/ PROCEDURES	EVALUATIVE COMMENTS
Wiring Base and Patch Panel and setting LGM, GM and TGM switches for several configurations that may be used in operational environment.	Given specifications for construction of system functional block diagrams and placed in a shelter in teams of two with all TM and training materials.	1. Training was procedurally oriented hands-on experience which appeared to contain many elements that soldier in field will perform.
QRA Erection	Used a procedurally oriented manual with task oriented steps; followed steps involved in erection of V3 antenna.	2. Training was identical to what was later observed during FOT&E--good procedurally oriented training.
V2 Antenna Erection	Used a procedurally oriented manual with task oriented steps--followed steps through A-Frame installation	3. To point provided, training was good; however, many of the steps involved in antenna erection, alignment and wave-guide attachment were not performed. No training was provided in site layout or operation of Pionjar to drill holes and set anchors in ground.

TABLE 5 (cont.)

TOPICS COVERED	TRAINING MATERIALS/ PROCEDURES	EVALUATIVE COMMENTS
Trouble-shooting	Problems were purposely programmed into equipment to provide a basis for error detection and correction.	4. The first half of this training was operationally relevant to what operators are authorized to do given problems which could arise during system set-up. Given that operators are authorized to perform only minimal maintenance, the second half of this training had little relevance for Army Operators. As a methodology for troubleshooting, the use of flow charts to show the sequence of steps in checking together with more detailed discussion in a document referenced by the flow charts provided a systematic procedure for identifying problems. Three major concerns were noted with these materials:
	a) First two exercises involved programming errors into BBPP, cards (CCA) switch settings and IF TEST PANEL modifications.	a) Both flow charts and referenced descriptive information were in extremely thick manuals with poor binding; working with such documents within a restricted area was difficult.

TABLE 5 (cont.)

TOPICS COVERED	TRAINING MATERIALS/ PROCEDURES	EVALUATIVE COMMENTS
	b) Two additional exercises involved loosening wires on one or more system components to cause CESE (Alarm Panel) indications and fault LED on the component affected to be lit.	b) Rather than having all flow charts in one document and referenced supplementary information in another, it would be better to collate this information in separate smaller documents for each component.
		c) Based on rather limited exposure to these troubleshooting materials, it appears that there are errors, both of omission and comission--e.g., (error of omission) FO 57 (Sheet 1 of 2), TO 31R2-2TRC-170-1-5, the fourth box down should have added "if can't be done, continue" and in the box which says "Go to PARA 6-9" add "if error still exists go back to START". Procedural documentation would be improved if unit emphasis was placed on reporting such problems as they are noted e.g., 2 (error of comission) FO 70, problems may exist with VOCU regardless whether the VOCU LED is lit or not as the flow chart indicates. Discussion with maintainer (PIN 601) indicates that this FO needs to be re-designed to be useful--probably by Raytheon.

TABLE 10

Procedures for Setting Up Shelter for Operation for Use During Training

1. Given specifications, create a Functional Block Diagram.

2. Wire BBPP using Functional Block Diagram as guide.

   a. If DOW is to be encrypted, wire DLED.

3. On Tropo Modem Control Panel:

   a. Set GROUP RATE switch to input group rates. CLOCK SOURCE switch to GROUP. (Given on crew assignment sheets.)

   b. Set MISSION RATE switch to match Mission data rate. CLOCK SOURCE switch to mission. (Given on crew assignment sheets.)

4. Turn on LGM:

   a. An CCA (A5) TMG GEN Set GP RATE (group traffic bit rate) thumbwheel switch (at bottom) to:

Thumbwheel switch Position	Group Traffic Bit Rate (Kbs)
0	Not used
1	Not used
2	128
3	144
4	256
5	288
6	512
7	576

Group Traffic Bit Rate

bits in sampling clock X bits in # channels used

bits in sampling clock	7 8	8 9	15 16	16 18	Channels bits
16	128	144	256	288	
32	256	288	512	576	

   b. On CCA (A5) TMG GEN Set CHAN RATE (on top) at 16 or 32 will correspond to bit sampling clock bite used to obtain the Group Traffic Bit Rate. (See crew assignment sheet.)

c. Assure that CCA (A6-A13) are LPMDM or AAU according to System Specifications on Crew Assignment Sheet.

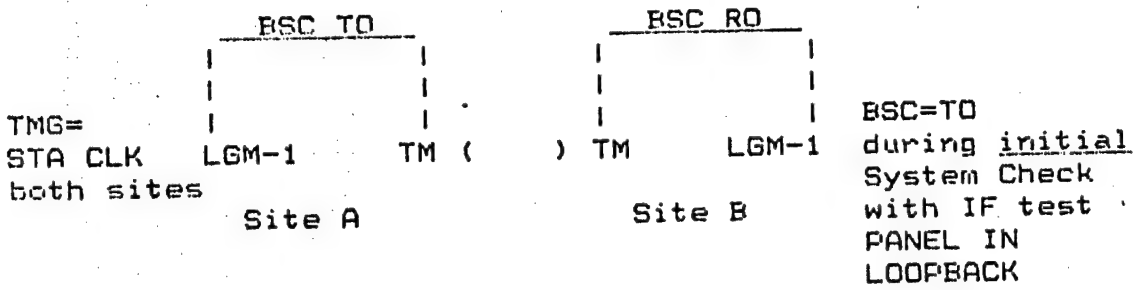
CCA	CHANNEL CONTROLLED			DIGITAL DATA		VOICE (ANALOG) DATA	
A6	(BOT)	1-2	(TOP)	LP MDM	or	AAU	(Be sure to
A7	(BOT)	3-4	(TOP)	LP MDM	or	AAU	verify those
A8	(BOT)	5-6	(TOP)	LP MDM	or	AAU	channel
A9	(BOT)	7-8	(TOP)	LP MDM	or	AAU	positions by
A10	(BOT)	9-10	(TOP)	LP MDM	or	AAU	use of "Road
A11	(BOT)	11-12	(TOP)	LP MDM	or	AAU	Map" (covers
A12	(BOT)	13-14	(TOP)	LP MDM	or	AAU	for LGM 1 &
A13	(BOT)	15-16	(TOP)	LP MDM	or	AAU	LGM 2)

d. For channels used on LP MDM CCA, set POWER FEED switch ON; others should be OFF.

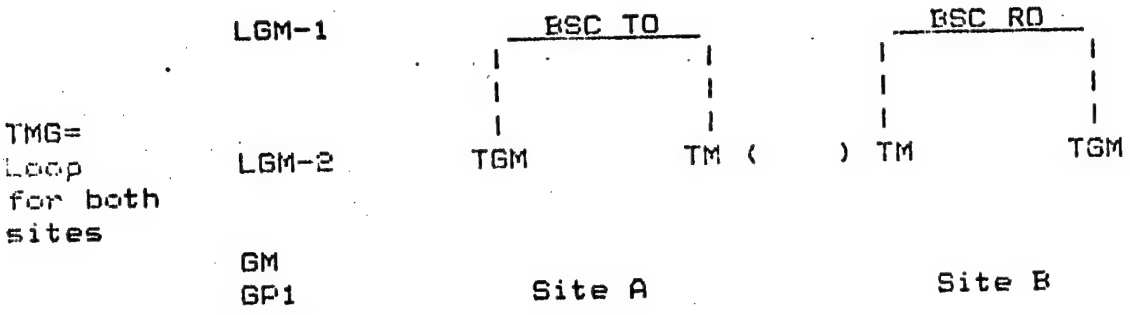
e. For channels on AAU CCA, set TRF switch to NORM.

f. On CCA (A16) INFTC, set TMG switch for site.

1. Site A is MASTER, Site B is SLAVE
BBPP: BSC TO only one LGM to TM



2. Site A is MASTER, Site B is SLAVE
   BBPP: BSC TO
   More than one LGM/GM



5. Turn on GM:

   a. On CCA (A4) DPHS A, set RATE Thumbwheel switch for GM-1 (MODEM 1) to select required group transit/receive traffic bit rate.

Rate Position Thumbwheel Setting	Receive/Transmit Bit Rate (Kbs)
0	OFF (when Group Modem is not being used)
1	72
2	128
3	144
4	256
5	288
6	512
7	576
8	1024
9	1152
10	1536
11	2048
12	2304
13	4096
14	4608

b. An CCA DPHS B (A5) set DW switch.

Position
SYST----DOW DVOW communication mode
MAINT---AVOW maintenance communication mode

c. On CCA DPLS (A7), set traffic transmission TRF toggle switch (on top).

Position
NORM----Normal transmission of data through Modem 2
LOOP----Used with TD 754 fault locating routine

d. An CCA DPLS (A7), set GP RATE thumbwheel switch to set traffic data rate for transmitting and receiving group data and timing for GM-2 (Modem 2).

Position	Modem Traffic Data Rate (Kbs)
0	OFF (when group channel is not used)
5	288
7	576
9	1152
12	2304

e. An CCA BPLR (A11) for Modem 3:

1. Set TRF toggle switch.

Position
NORM----Normal transmission of data through Modem 3
LOOP----Used with TD754 fault locating rating

2. Set XMT toggle switch.

Position when pulse restorer is not used	Position when pulse restorer is used	Setting Data
1	1	1/4 mile cable length
2	2	1/2 mile cable length
3	3	3/4 mile cable length
4	4	1 mile cable length
2*	-	0 mile cable length

3. Set RCV toggle switch.

Position when pulse restorer is not used	Position when pulse restorer is used	Setting Data
3	1	1/4 mile cable length
4	2	1/2 mile cable length
1	3	3/4 mile cable length
4	4	1 mile cable length
2*	-	0 mile cable length

*For Loop Back check

4. Set GP toggle switch.

Position

15 enables NRZ data output function
0 disables NRZ data output function

f. On CCA DPHS A (A14) for Modem 4 make setting as described in 5a. above.

g. On CCA DPHS B (A15) for Modem 4 make settings as described in 5b. above.

6. TGM Turn On:

a. On CCA GP MUX (A5)--input from GP 1 (port 1 on TGM).

1. Set FRAME switch YES--must be YES always for Group 1 (unencrypted data, highest group rate).

2. Set GP RATE thumbwheel switch to Group 1 transmit/receive traffic bit rate.

Position	Group Traffic Bit Rate (Kbs)
0	OFF (when Group Channel is not being used)
1	72
2	128
3	144

TABLE 10 (cont.)

Position	Group Traffic Bit Rate (Kbs)
4	256
5	288
6	512
7	576
8	1024
9	1152
10	Not used
11	2048
12	2304

b. On CCA GP MUX (A6-A8) (Group 2-4).

1. Set FRAME switch:

Position
YES-----Data clear and unencrypted
NO------Data encrypted or no input to TGM (port group) x

2. Set GP RATE thumbwheel switch as shown in 6a(2) above.

c. On CCA (A9), set TGM:

Position
STA CLK
LOOP

d. On CCA (A10) SUP GROUP, set SUP GP RATE thumbwheel switch.

Position*	Summed Group Traffic Bit Rate (Kbs)
2	128
3	144
4	256
5	288
6	512
7	576
8	1024
9	1152
10	1536

TABLE 10 (cont.)

Position*	Summed Group Traffic Bit Rate (Kbs)
11	2048
12	2304
13	4096
14	4608

*Positions 0, 1 and 15 cannot be selected.

e. On CCA (A12) SUP GP, set CHAN RATE.

Position
32) Set same as CHAN RATE on LGM
16)

f. On CCA (A12) SUP GP, set FORMAT thumbwheel switch.

Position	Ratio of TGM Group Inputs
0	4:2:1:1
1	2:1:1
2	1:1:1:1
3	1:1
4	1:1:1
5	4 RLGM
6	2 RLGM
7	Single Group

TABLE 12

Potential Training Problems as Documented by Reported Observations, Impact of Those Observations and Possible Remediation - Based on October 1986 Interviews

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Experienced difficulty with set-up/operation of:		
Item		
1. RF Amplifier		
(1) Couple of overheats from cold starts (forgot to open vents) (1)	(1) Caused communications interruption	(1) Stress strongly use of TM steps as checklist performance items.
8. Klystron		
(1) Adjustment/ tuning problems (7)	(1) Caused communications interruption	(1) Procedures for "Preliminary Set-Up for TROPO Mode" (Table 4-27, pp 4-65 to 4-66) and "Turn-On and Checkout for TROPO Mode" (Table 4-28, pp 4-67 to 4-69) are detailed and need to be strictly followed to avoid damage to the Klystron and to assure communication can be established. For example, in Tuning Cavity, tuners (1-5) should not be turned below 50 or above 950--to do so "the mechanism may become disengaged or tube damage may result" (p 4-66). Tuning must be

TABLE 12 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
8. Klystron (cont)		done from CCW direction (p 4-66). Step 15, p 4-68 is incomplete; end of step as now exists should be followed by "and RF OUTPUT-TROPO kilowatt meter should increase" Spot unobtrusive check by Data Collectors that the TM procedures are being followed would address the seriousness of this training concern. Strong unit emphasis on use the TM steps as checklist performance steps would minimize errors reflecting insufficient training.
14. TED 1 and TED 2		
(1) Problems loading variable (7)	(1) Establishing communications is delayed	(1) Training provided with TED has emphasized procedures to be followed in individual vans and did not focus much on the coordination required by all communicating elements. Since materials/procedures used are classified (CONFIDENTIAL), additional unit level training which stresses parts of the procedures which involve coordination would be desirable.

TABLE 12 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
17. Base Band Patch Panel (BBPP)		
(1) Short on practice with patching getting resyn commands (1)	(1) Communications delay	(1) Unit training which stresses establishing communications in different system configurations would provide realistic training leading to greater operational proficiency.
25. Orderwire Control Unit		
(1) Electronic Bridge (orderwire) locks up (16) (2) VINSON difficulty loading or dropping variables (8)	(1)-(2) Secure voice communication needed in configuration change or reloading a variable is disrupted, but does not disrupt traffic.	(1)-(2) Coordination between Raytheon and COMSEC personnel on examining and streamlining procedures for establishing and maintaining secure voice communication is needed. If warranted, this should be followed by training/practice by all MOS 26Q in different system configurations. IF NEW PROCEDURES ARE NOT DEVELOPED, THIS MAY BE A TRAINING PROBLEM.
28. Analog Voice Order Wire (AVOW)		
(1) Malfunctioning such as signalling alarms for some unexplained reason or ringing when not in use (5)	(1) Creates distracting rings at best and inability to communicate with insecure voice at worst.	(1) Determine whether reported problems are due to incorrect use of equipment.

TABLE 12 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
31. Remote Order Wire Control Unit (ROCU)		
(1) No training on repair given at Keesler (1)	(1) Inability to service when malfunctioning	(1) Consider providing maintainers with ROCU repair experience.
(2) Apparent malfunctions (7)	(2) Secure voice communication through the ROCU away from shelter sometimes does not work.	(2) Review reports submitted by operators during FOT&E against procedures--preferably done with Raytheon Rep and a procedures analyst.
a) Will not work when running one HPA and other is in loopback (1)		
b) Fault (red LED) light does not signal alarm, but green (LED) does (1)		
c) Cannot ring and/ or talk to distant end but only your shelter (5)		
(3) Did not know Signal Entry Panel to use(1)		(3) TM on page 6-226 step 6-10.13 a specifies Signal Entry Panel to use. On some equipment at Keesler, Units were identified by painting name on unit. It is understood that prior to shipment of TRC-170 to Ft. Huachuca, government painted all equipment--identifying information may have been inadvertently covered up.

TABLE 12 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
Not SQT qualified with current training experience in:		
40. Fault Diagnosis Using BITE		
(1) Too busy talking theory in training--not enough on interpretation of BITE (1)	(1) Interpretation and required action from BITE indications lacking.	(1) Include more training on interpretation and recommended action for different BITE indications.
41. Performing PMCS		
(1) PMCS books are either not in vans, exist only for DGM equipment or are not known to exist (6)	(1) Over the short term, there may be no adverse effect; however, greater number of malfunctions can be expected down-the-road.	(1) Develop/obtain PMCS from Raytheon. With seven years of development work for the AF, PMCS must exist.
42. Remove/Replace Shelter Components		
(1) Could do lot more than we do if authorized to and given Risk Kits (9)	(1) With Army's allocation of one maintainer per unit and points more distant in the communication network than for earlier, unless Operators are permitted/ trained to do some of the more simple maintenance	(1) Requested a Maintainer to go through MAC and based on his best judgement, make a list of maintenance tasks which he feels Operators could be trained to do. Requested that list of these recommended tasks be forwarded to OTEA Test Directorate for review.

TABLE 12 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
42. Remove/Replace Shelter Components (cont.)	activities, system "down time" may well be significantly increased. Use of "down-time" during FOT&E due to particular problems that had to be serviced by maintainers could be computed.	
44. Assembly of 9.5 ft Antenna		
(1) Would be good for training purposes if V3 team members switched to V2 to get V2 antenna assembly/ disassembly experience (2)	(1) Soldiers assigned only to V3 will tend to lose their ability to assemble/ disassemble V2 antenna.	(1) Provide for interchange of V2 and V3 personnel periodically or assign soldiers on V2 one skill identifier and those assigned to V3 another.
48. Antenna Adjustment		
(1) Difficult especially at 3am using a flashlight to insert the long-handled rod into (1)	(1) Making this adjustment with one person would increase time needed to complete adjustment.	(1) For night time adjustment, make this task a two man effort or provide adjustable helmet spotlight to Operators

TABLE 12 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
50. Pionjar Operation/Maintenance		
(1) Little or no Pionjar training/ maintenance at Keesler AFB (2)	(1) Can create delays in drilling appropriate anchor holes and/or inadequate maintenance could result in required maintenance (premature) and shortened life of this device.	(1) Offer the two hour Pionjar training provided prior to FOT&E at Keesler or as a programmed part of unit training after Keesler program has been completed.
80. Improvement in Training Aids Needed		
(1) Need better and more simplified handouts to be consistent with amount of maintenance Operators can do (2)	(1) Training would be simplified	(1) Many of the Current and Block Diagrams (C&D) used at Keesler did not contain information which was procedural and thereby related to operations. It appeared that these materials provided a vehicle for presenting information upon which factually oriented PC and Block test items could be constructed. In most cases C&D diagrams could be omitted with little loss of understanding of operational procedures.

TABLE 12 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
81. Improvement in Training Devices Needed		
(1) Problems with some of equipment used in Keesler training (3)	Prevented hands-on training	(1)-(3) Tasks identified prior to FOT&E as critical but not trained at Keesler should be incorporated into the course and much of the theory and more maintenance oriented C&D Diagrams should be deleted.
(2) Need Pionjar training (2)	(2) Needed to be trained at Ft. Huachuca	
(3) Need antenna set-up/tear-down training (2)	(3) See (2) above.	
82. Appropriateness of Amount of Classroom Training		
(1) Need more hands-on and practical exercises (25)	(1)-(3) Operators who are placed in a field environment with still considerable learning required.	(1) Training which places more emphasis on use of equipment in different configurations and actual exercises is needed.
(2) More trouble-shooting training (4)		(2) More training on troubleshooting together with greater authorization for Operators to perform simple maintenance tasks.
(3) More training how to read TM (1)		(3) Reduce TM theory content and make TM more procedurally oriented.

TABLE 12 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
83. Collective Unit Training Needed		
(1) Communication of company SOP in the field (2)	(1) Will eventually be made known	(1)-(3) Bring concerns to company NCO for resolution.
(2) Company lacks interest in training and/or is more concerned with "Detail" work like mowing grass (7)	(2) Unless emphasis is placed on training and less on "looking good" instead of "being good", morale problems will develop.	
(3) Specific training		
a) 3 to 4 times a year, two to three weeks at a time (1)		
b) Maintenance training (3)		
c) Generator training (1)		
84. Critical Tasks Not Trained		
(1) Interface with other equipment, e.g., DS/VT telephone (3)	(1)-(14) Training was provided prior to FOT&E at Ft. Huachuca; not having this training at Keesler meant soldiers were less up on the	(1)-(14) Tasks identified as critical such as these should be identified and an understanding needs to be reached on which of these tasks will be incorporated into the D6 training course and
(2) Use of COMSEC gear (2)		

TABLE 12 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
83. Collective Unit Training Needed (cont.)		
(3) More training on trouble-shooting (3)	learning curve than they might have been.	which will be trained OJT or as part of the collective unit training.
(4) LPA set up (4)		
(5) Pionjar operation (3)		
(6) Antenna alignment (1)		
(7) Maintenance training (1)		
(8) Site layout (4)		
(9) System checkout with loop back test (1)		
(10) Be trained in Basic Electronics at Ft. Gordon before going to Keesler (1)		
(11) Generator operation/set-up (1)		
(12) Configuration setups (1)		
(13) V2 antenna set-up (1)		
(14) Removal of Klystron (1)		

TABLE 12 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
85. Other Training Problems Observed		
(1) Link engineering (1)		(1) Unclear what specific training is required.
(2) Use the system in a tactical environment (1)	(2) Soldiers will be less proficient than they would be with this experience.	(2) Conduct of tactical exercises as part of collective unit training should meet this need.
88. Areas Where Amount of Training Not Adequate		
(1) COMSEC interface (1)		
(2) Radio Theory (2)		
(3) Generator operator/ maintenance (1)		
(4) Antenna setup/alignment (1)		
(5) More maintenance training for Operators (2)		
(6) Trouble-shooting (1)		
(7) More field set-up or hands-on (2)		

TABLE 12 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
88. Areas Where Amount of Training Not Adequate (cont.)		
(8) Operator (procedural) training rather than Maintainer oriented training (1)		
(9) Basic Electronic Theory training (1)		

TABLE 13

Potential MANPRINT Problem in Human Factors as Documented by Reported Observations, Impact of Those Observations and Possible Remediation Based on October 1986 Interviews

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Experienced difficult with set-up/operation of:		
Item		
3. Control Logic Assembly CCA		
(1) Cards have to be replaced or reseated (3)	(1) Communication interruption	(1) Assure that Operators have replacement CCA in van and receive training/authorization in problem recognition and CCA replacement/reseating procedures. Asked a Maintainer to review MAC charts and make a judgement about what types of maintenance tasks Operators could do and to provide this information to the OTEA Test Directorate.
8. (1) Problem tuning--reflects less than 1 KW output and output fluctuating--LED matrix in HPA had a D6 alarm which indicated under voltage or over current (1)	(1) Communication interruption	(1) Procedure for Step 15 in "Turn-on and check-out for TROPO mode (Table 4-28, p 4-68) is incomplete; end of step as now exists should be followed by "and RF OUTPUT-TROPO kilowatt meter should increase" Two DRIVE ADJUST settings will give an indication of "green" on the DRIVE meter--with one, however, the RF OUTPUT-TROPO kilowatt meter does not increase. This is the incorrect DRIVE ADJUST setting.

TABLE 13 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
10. Down Converter Assembly		
(1) DC power circuits leading to DOWN Converter hard to find--not correct. LVPS alarm in LVPS itself was only an indication but fault was not in LVPS. Raytheon took two days to get fixed--troubleshooting diagrams in TM did not help (1)	(1) Communication interruption	(1) Modify CESE Message Generator circuitry to make fault detection easier and/or modify troubleshooting charts to make problem identification easier.
12. TROPO Modem Modulator		
(1) Need to reseat/replace cards (7)	(1) Communication interrup-	(1) Assure that Operators have replacement CCA in van and receive training in problem recognition and CCA replacement/reseating procedures. See request made of a Maintainer noted in Item 3 above.
13. TROPO Modem Demodulator		
(1) Need to reseat/replace cards (5)	(1) Frequently cause interruption of communication	(1) Assure that Operators have replacement CCA in van and receive training in problem recognition and CCA replacement/reseating procedures. See request made of a Maintainer noted in Item 3 above.

TABLE 13 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
16. Low Voltage Power Supply (LVPS)		
(1) DC power circuits leading to DOWN Converter hard to find--not correct. LVPS alarm in LVPS itself was only an indication but fault was not in LVPS. Raytheon took two days to get fixed--troubleshooting diagrams in TM did not help (1)	(1) Communication interruption	(1) Modify CESE Message Generator circuitry to make fault detection easier and/or modify troubleshooting charts to make problem identification easier.
(2) 5.3V and 28V fuses went out (1)	(2) Communications interruption	(2) Assure that Operators have spare fuses in van and receive training in problem recognition and fuse replacement procedures.
(3) Card went out once (1)	(3) See (2) above	(3) Assure that Operators have spare cards in van and receive training/authorization in problem recognition and card replacement.
17. Base Band Patch Panel (BBPP)		
(1) Connections in back were loose (2)	(1)-(2) Communications interruption	(1) Allow soldiers to tighten connections as guided by trouble-shooting charts.

TABLE 13 (cont.)

Item	OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
17. Base Band Patch Panel (BBPP) (cont.)			
	(2) Don't get into syn with other end; short on practice with patching getting resyn commands (1)		(2) Unit (collective) training should give practice in completing BBPP wiring for different system configurations where established training aids indicate wiring correctness.
18. Loop Group Multiplexer			
	(1) Supply of cards not sufficient either for potential configuration or for replacing bad cards (4)	(1) Problem satisfying configuration needs or replacing cards which go bad	(1) Assure Operators have replacement CCA in van and receive training in problem recognition and CCA replacement/reseating procedures. See request made of a Maintainer noted in Item 3 above.
19. Group Modem			
	(1) Removed/ replaced cards (1)	(1) Communications interruption	(1) Assure Operators have replacement CCA in van and receive training/authorization in problem recognition and CCA replacement/reseating procedures. See request made of a Maintainer noted in Item 3 above.

TABLE 13 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
20. Trunk Group Modem		
(1) One card had to be replaced before record test started (2)	(1) Communications interruptions	(1) Assure Operators have replacement CCA in vand and receive training/authorization in problem recognition and CCA replacement/reseating procedures. See request made of a Maintainer noted in Item 3 above.
25. Order Wire Control Unit		
(1) Electronic bridge locks up and/or VINSON drops Variable (17)	(1) Secure voice communication needed in configuration change or reloading a variable is disrupted but traffic is not disrupted; consequently HF radio is required.	(1) Coordination is needed between Raytheon and COMSEC personnel to examine and streamline procedures for establishing and maintaining secure voice communication. If warranted, this should be followed by a short course to key unit personnel trainers, and in turn followed by training/practice by all 26Q MOS in different system configurations. IF NEW PROCEDURES ARE DEVELOPED, THIS WAS A HUMAN FACTORS PROBLEM.

TABLE 13 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
25. Order Wire Control Unit (cont.)		
(2) Trouble-shooting chart (Fig FO-70) in TM was confusing-- symptoms given (and observed) to direct the troubleshooting activity were not definitive or unique (1)	(2) Maintainer must have greater theoretical understanding of the system to solve the problem; meanwhile secure voice communications needed a least during configuration changes are disrupted.	(2) Fig FO-70 in TM should be rewritten to be definitive. A Maintainer indicated he would attempt to prepare a revised troubleshooting diagram and forward to OTEA Test Directorate for review.
28. Remote Order Wire Control Unit (ROCU)		
(1) Had problem because didn't know which Signal Entry Panel to use (1)	(1) Delayed operational readiness of ROCU	(1) TM on page 6-226, step 6-10.13a specifies Signal Entry Panel to use. On equipment at Keesler, units were identified by stenciled painting of name over unit. It is understood that prior to shipment, government painted all equipment--identifying information may have been inadvertently covered up. Inspection of local AF AN/TRC-170 units to determine parts which need to have stenciled identification replaced is desireable; painting identifying information on each Army unit should then be performed.

TABLE 13 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
40. Fault Diagnosis Using BITE		
(1) Too busy talking theory in training--not enough on interpretation of BITE (1)	(1) Interpretations and required action from BITE indications lacking.	(1) Include more in training on interpretation and recommended action for different BITE indications.
41. Performing PMCS		
(1) PMCS books either are not in vans or they do not appear sufficiently detailed (4)	(1) Over the short term, there may be no adverse effect; however, greater number of malfunctions can be expected down the road.	(1) Develop/obtain PMCS from Raytheon. With seven years of development work for AF, PMCS must exist.
42. Remove/Replace Shelter Components		
(1) Not authorized to do much; could do a lot more if given Risk Kit and authorization (9)	(1) With Army's allocation of one Maintainer per unit and points more distant in the communication network than for earlier communication systems, unless Operators are permitted/ trained to do some of the more simple maintenance activities, system "down time".	(1) See request made of a Maintainer noted in Item 3 above.

TABLE 13 (cont.)

Item	OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
42. Remove/Replace Shelter Components (cont)		may well be significantly increased. Use of "down-time" during FOT&E due to particular problems that had to be serviced by Maintainers could be computed.	
44. Assembly of 9.5 ft Antenna	(1) Would be good for training purposes if V3 team members switched to V2 to get V2 antenna assembly/ disassembly experience (1)	(1) Soldiers assigned only to V3 will tend to lose their ability to assemble/ disassemble V2 antenna.	(1) Provide for interchange of V2 and V3 personnel periodically or assign soldiers on V2 one skill identifier and those assigned to V3 another.
46. Antenna Adjustment	(1) Difficulty especially at 3 am using a flashlight to insert the long handled rod into (1)	(1) One person making this adjustment would increase the time needed to complete adjustment.	(1) For night time adjustment, make this task a two man effort or provide adjustable helmet spotlight to Operators.

TABLE 13 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
50. Pionjar Operation/Maintenance		
(1) Received little or no Pionjar training (operation/ maintenance) at Keesler AFB (2)	(1) Can create delays in drilling appropriate anchor holes and/or inadequate maintenance could result in required maintenance (premature) and shortened life of this device.	(1) Offer the two hour Pionjar training provided prior to FOT&E at Keesler or as a programmed part of unit training after Keesler program has been completed.
Not SQT qualified with current training/experience in:		
51. Pocket Transit Operation and Interpretations		
(1) Difficult to use without a transit (4)	(1) Task is difficult in the daylight, even more difficult at night--unclear whether sightings made are are within an acceptable error tolerance for optimal communication.	(1) Conduct a "side test" on sighting accuracy/time using lensmatic compass (with /without transit) and a standard compass-- perform test with at least five (5) Operators trained to perform the task with each device.

TABLE 13 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
52. Army Supply System Not Providing Needed TRC-170 Parts		
(1) Supply channel for TRC-170 is closed until a TOE is assigned. Need for Risk Kit: a) Standard supply of pins which get lost or break (4) b) Anchors (7) c) Cards for DGM equipment (7) d) Cards for Synthesizer and VOCU (1) e) Fuses (1) f) Hose clamps (2) g) LPA base-plates (1) h) BITE cards for TROPO modem (1) i) 40 weight oil for Pionjar (1)	(1) For a new system which has been through seven years of development work, there seems to be a large number of spare parts required. To prevent the TRC-170 system from becoming rapidly degraded, establishment of a TOE is needed.	(1) Establish a TOE for TRC-170, include in Risk Kits for each shelter, parts which get lost or broken easily. Many of the replacement/maintenance tasks should be turned over to Operators if for no other reason than the distance a Maintainer must travel between communication nodes--to reduce DOWN time. See request made of a Maintainer noted in Item 3 above.

TABLE 13 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
54. Clarity of Information Presented in TMs		
(1) TM not clear; contains redundancies, lacks specificity, material appears out of sequence, contains contradictions and is not concise (12)	(1) Problem in operation and problem identification exist.	(1) Much of the theory and system description should not be in Operators TM, as well as schematics, wiring diagram, and parts description. For Operators, TM should contain addresses of system components, detailed labeling of parts and basically their function (in same part of TM), set-up/operational Procedures and, if authorized to perform minimal maintenance tasks, troubleshooting flow charts and interpretation on problem resolution.
55. Ease of Looking Up Information in TM		
(1) Problem finding things in TM (11)	(1)-(2) Causes delay in troubleshooting.	(1) Elimination of much of the theory and system description, together with schematics, wiring diagrams and parts description would be a good beginning. For Operators, TM should contain addresses of system components, detailed labeling of parts and basically their function (in same part of TM), set-up/ operational procedures,
(2) Needs index for cross referencing and tabs (2)		
(3) Too much maintenance type information such as wiring diagrams and schematics (2)	(3) Much irrelevant information which must be processed.	

TABLE 13 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
55. Ease of Looking Up Information in TM (cont.)		
(4) Trouble-shooting charts are not complete enough or always available (3)	(4) Takes longer to diagnose problems.	and if authorized to perform minimal number of maintenance tasks, troubleshooting charts with interpretation (in same part of TM). With this reduced TM, creation of an index for cross referencing and tabs would make the TM very usable.
56. Compactness and Ruggedness of TM for Operational Environment		
(1) Not rugged enough (12)		
(2) Loosing pages, firm binder needed (18)		
(3) TM too large with many parts not needed by Operators (13)		
(14) Need storage space for TM (5)		

TABLE 13 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
58. Common/Specific Tools Needed		
(1) Rubber mallets (5) (2) Cable cutters (4) (3) Large (star) Pionjar bits (4) (4) Rat-tail file (3) (5) Large/small sledge hammers (2) (6) Different anchors (e.g., rock) (2) (7) Wrench for AZ/EL Assembly (2) (8) Wrench for generator (1) (9) Extra pins (cam & push button) (1) (10) Spare cards for DGM equipment (1) (11) Silcon (dry-film) spray (1) (12) Stepladder (1)	(1)-(17) Availability would make set-up/tear down and operations smoother probably with less DOWN time.	(1)-(17) Provide these added tools.

TABLE 13 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
58. Common/Specific Tools Needed (cont.)		
(13) Pick-axe (1)		
(14) Ratched Allen wrench (1)		
(15) Helmet spot-light (1)		
(16) More shelter storage (1)		
(17) Rope template for LPA (1)		
59. - 60. Erection/Disassembly of LPA With Any Three		
(1) Need a better way (3)	(1) Performing these tasks with current equipment can create health hazards and can be dangerous.	(1) Modify LPA base-plate to conform to design of HF antenna or modify current erection procedures, e.g., measure guy-wire length on erected LPA antenna and anchor two of these guy-wires prior to beginning to "walk" antenna up. This would allow two soldiers to hold antenna pole from moving at its base as it is being walked up.

TABLE 13 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
62. - 63. Erection/Disassembly of 9.5 ft Antenna With Any Three		
(1) Need a step-ladder to get pins in/out of petals connecting to hub (3)	(1) Performing these tasks without a step-ladder with short Operators can be difficult. Holes into which pins must be inserted to connect upper reflector petal to hub requires close alignment of holes and is difficult to reach.	(1) Include a step-ladder as standard equipment to be stored on the low profile pallet to aid in erection/disassembly of of 9.5 ft antenna and installing and taking down camouflage.
67. Any Three Get TRC-170(v)2 Operational in 5 Hours		
(1) If a step-ladder is available (2)	(1) See comment immediately above.	(1) See comment immediately above.

TABLE 14

Potential MANPRINT Manpower Problems as Documented by Reported Observations, Impact of Those Observations and Possible Remediation Based on October 1986 Interviews

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
53. Current #26Q and/or 29M Not Adequate for Mission Performance (n=36)		
(1) Need more V2 Operators (35) (2) Need more V3 Operators (21) (3) Need more Maintainers (22)	(1)-(3) Insufficient personnel can create health hazards and system safety concerns as well.	(1)-(3) It is generally understood that the AN/TRC-170 system was designed for four man crews and that in the TOE developed by the Army, three man crews were planned. Test Directorate judgements combined with those of 26Q Operators and 29M Maintainers indicate that the Army TOE (even when circumstances do not preclude the full crew complement) will create set-up/tear down difficulties. Particular difficulty arises in attempts of 3 man crews to set-up the LPA and some portions of V2 antenna assembly/disassembly. It is also generally estimated that one Maintainer per unit is not adequate to assure efficient unit performance. Crew Size Issue While the procedures developed for TRC-170 by Raytheon for the AF specify 4 man crews, it is not clear that this

TABLE 14 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
53. Current #26Q and/or 29M Not Adequate for Mission Performance (n=36) (cont.)		
		specification takes into consideration all the peripheral tasks/activities including patrol of the perimeter and personal needs like sleeping. Some soldiers reported going 24-36 hours without sleep on "move" days and during the FOT&E sentry duty was not required. Given the entire scope of projected activities required for 26Q personnel, it remains questionable whether even four man crews would be sufficient. Within the narrower context of TRC-170 set-up/tear down operation tasks alone, it is possible that many of the tasks currently calling for 4 soldiers may be modified to be done by three. For example, removal/replacement of the nested truss might be performed by disassembly/reassembly on the transport vehicle. At this time it is not clear whether there is sufficient space on the transport vehicle to

TABLE 14 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
53. Current #260 and/or 29M Not Adequate for Mission Performance (n=36) (cont.)		perform this task. A highly motivated TRC-170 team (of 3) would need to work with HF/Procedural Analysts to determine if and how this might be accomplished. In the case of the LPA assembly/disassembly two options bear consideration: (1) Procedures utilizing current equipment with three man teams might be developed. One procedure involves emplacing two of the guy wires into the anchored positions and fastened to the pole prior to beginning to walk the pole up. This requires making measurements of the length of wire between the ground anchor position and the point of attachment to the pole. Marking of the wires with e.g. enamel red paint to preclude the necessity of measurement each time would be desireable. In this case, one soldier could walk up the pole and two could hold the base of the pole to prevent if from "walking".

TABLE 14 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
53. Current #260 and/or 29M Not Adequate for Mission Performance (n=36) (cont.)		
		(2) Another alternative is to make a baseplate which is hinged (like that used for the HF antenna). This equipment modification in conjunction with the suggested procedural modification might well make the LPA assembly/disassembly a safe doable task by 3 man teams. Again a motivated team working with HF/Procedural Analyst personnel would be desireable before any decision for change is recommended for system-wide implementation.
59. Any Three Cannot Erect LPA		
(1) Need at least 4 (14)	(1) With three using current procedures can be a health hazard.	(1) See discussion under (1) and (3) for "Crew Size Issue" in Item 53 above.

TABLE 14 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
61. Any Three Cannot Unload the Low Profile Pallet		
(1) Need 4 for some of lifts (5)	(1) Some parts such as the antenna truss assembly are heavy and removal in nested position can pose a health hazard for three soldiers with current procedures.	(1) It is possible that many of the tasks currently calling for 4 soldiers may be modified to be done by three. For example, removal/replacement of the nested truss might be performed by assembly/disassembly on the low profile pallet. At this time it is not clear whether there is sufficient space on the transport vehicle to perform this task.
62. Any Three Cannot Erect the 9.5 ft Antenna		
(1) Need at least 4 (9)	(1) Hub and AZ/EL Assembly are heavy and awkward for three soldiers. Health hazards and delay in getting the system operational will exist if only three soldiers are used with current procedures.	(1) Consider alternate procedures--perhaps with two step ladders for two of three crew members during installation and disassembly.
63. Any Three Cannot Disassemble the 9.5 ft Antenna		
(1) Need 4 (5)	(1) See comment for Item 62 above.	(1) See comment for Item 62 above.

TABLE 14 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
64. Any Three Cannot Maneuver V2 Shelter Into Position		
(1) Need at least 6 (10) (2) Need 4 or 5 (6)	(1) Attempting to maneuver the mobilizer can cause severe strain and on hilly terrain control of mobilizer can be lost.	(1) Problems with the M720 mobilizer during FOT&E strongly suggest that V2 shelter be stored atop an upgraded M720, a heavy duty M832 mobilizer or a 5 ton truck.
65. Any Three Cannot Maneuver the QRA Into Position		
(1) Need 4 (3)	(1) Potential health hazard.	(1) Train Operators to maneuver the QRA into position using towing vehicle.
66. Any Three Cannot Install a Complete Set of Ground Stakes (22 Stakes in a Time Limit)		
(1) Need 4 (3)	(1) Fatigue	(1) Where ground is hard or rocky, use of rock anchors may reduce the depth (and hence the effort expended) a hole must be drilled.
67. Any Three Cannot Get the TRC-170 Operational in 5 Hours		
(1) Need at least 4 (4)		(1) At other than end points, two TRC-170 shelters will probably be colocated. At these sites, task sharing may well facilitate set-up/ tear down operations. At end-point sites, either larger crew size or modified procedures are needed.

TABLE 14 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
70. Crew Size of Three for V2 Not Sufficient for Tactical Situations		
(1) Need at least 4 for LPA erection/ disassembly and to maintain site security (19)	(1) Potential system degradation due to inappropriate system manning or failure to prevent sabotage damage could occur.	(1) Appropriate Army personnel need to develop alternate probable duty assignments by time and duty function (MOS)--including rest--to arrive at a more accurate estimate of manpower requirement.
71. Crew Size of Three for V3 Not Sufficient for Tactical Situations		
(1) Need at least 4 for LPA erection/ disassembly and to maintain site security (13)		

TABLE 15

Potential MANPRINT Health Hazard Problems as Documented by Reported Observations, Impact of Those Observations and Possible Remediation Based on October 1986 Interviews

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
52. Army Supply System Not Providing Needed TRC-170 Parts		
(1) Attempting to raise LPA with three people instead of four resulted in a couple of Operators getting sprained wrists as they were walking up the antenna pole and it moved out of base plate--no one was holding the pole at the base plate (1)	(1) Hurt personnel.	(1) Use four soldiers in erection with current procedures or modify base plate to be like HF antenna base plate or modify current procedures as described for Item 52 on MANPOWER Problem table--Table 14, Appendix B.
53. Current #260 and/or #29M Not Adequate for Mission Performance		
(1) Using only 3 for LPA erection, base plate slipped and put pressure on wrist (1)	(1) Potential danger to personnel.	(1) See (1) for Item 52 above.
59. Any Three Cannot Erect LPA Safely		
(1) Need at least 4 to be done safely (16)	(1) See OBSERVATION comments for Items 52 and 53.	(1) Modify procedures for erection/ disassembly with three, modify the base plate or assure that 4 are available for this task.

TABLE 15 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
59. Any Three Cannot Disassemble LPA Safely		
(1) Need at least 4 to be done safely (11)	(1) See OBSERVATION comments for Items 52 and 53.	(1) Modify procedures for erection/ disassembly with three, modify the base plate or assure that 4 are available for this task.
61. Any Three Cannot Unload the Low Profile Pallet Safely		
(1) Much of the equipment is too heavy for three soldiers (5)		(1) Assure 4 soldiers are provided or modify procedures for loading/ unloading low profile pallet, e.g. disassembly of nested turss assembly while on pallet.
62. Any Three Cannot Erect 9.5 ft Antenna Safely		
(1) Safety is a concern with only three (6)		(1) Assure 4 soldiers are provided or modify procedures for V2 antenna erection/disassembly.
63. Any Three Cannot Disassemble 9.5 ft Antenna Safely		
(1) Safety is a concern with only three (6)		(1) Assure 4 soldiers are provided or modify procedures for V2 antenna erection/disassembly.

TABLE 15 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
64. Any Three Cannot Maneuver V2 Shelter Using Mobilizer Safely		
(1) Safety is a concern with only three (6)		
65. Any Three Cannot Maneuver QRA Into Position Safely		
(1) Safety is a concern (1)		
66. Any Three Cannot Get TRC-170 Operational in 5 Hours Safely		
(1) Safety is a concern (1)		

TABLE 16

Potential System Safety Problems as Documented by Reported Observations, Impact of Those Observations and Possible Remediation
Based on October 1986 Interviews

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
30. Flushing Fan		
(1) Vent leaked during rain (1)	(1) Could make van floor slippery.	

TABLE 18

Potential Equipment Problems as Documented by Reported Observations, Impact of Those Observations and Possible Remediation Based on October 1986 Interviews

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Experienced difficulty with set-up/operation of:		
Item		
1. RF Amplifier		
(1) When in high power and switching generators (1)	(1) Cause communications interruption.	(1) Introduce phase-in switch on generators to keep voltage constant when switching generators and check operational fluctuation in HZ output of generators.
(2) Closing the door to the HPA causes the RF meter to drop-off and requires readjustment (1)	(2) See (1) above.	(2) Check/repair (Team V34).
(3) RF FWD POW reading flucutates--got HPA alarm but receive/transmit operation not affected (1).	(3) None apparent.	(3) See (2) above.
3. Control Logic Assembly CCA		
(1) Cards go bad or need to be reseated (3)	(1) Cause communications interruption.	(1) Check CCA for possible quality control problem or defect/correct. Check where CCA seat for loose connection, poor fit, design problem.

TABLE 18 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
4. High Power Voltage Supply		
(1) Problems being looked at by Raytheon (2)	(1) Causes communication interruption.	(1) Diagnosis/remedy.
(2) Get surge or difficult to reset when change generators (2)	(2) See (1) above.	(2) Introduce phase-in switch on generators to keep voltage constant when switching generators and check operational fluctuation in HZ output of generators.
5. Fast Interrupt (FSINT) Assembly		
(1) Light does not come on wher it should (1)	(1) Uncertain.	(1) Diagnose/remedy if necessary.
(2) There is a light on the power surge assembly, Maintainer has not been able to fix (1)	(2) Uncertain.	(2) See (1) above.
6. Inverters		
(1) Replaced one (1)	(1) Causes communication interruption.	(1) Diagnose/remedy.
7. RF Protect and Metering		
(1) Problem is with generators, replaced fuses by Raytheon--fuse not in supply system yet (1)	(1) Causes communications interruption.	(1) Diagnose/remedy.

TABLE 18 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
7. RF Protect and Metering (cont.)		
(2) RF FWD power fluctuation (1)	(2) See (1) above.	(2) See (1) above
8. Klystron		
(1) Problems powering up especially when change generators (3)	(1) Communication interruption.	(1) Introduce phase-in switch on generators to keep voltage constant when switching generators and check operational fluctuation in HZ output of generators.
(2) Raython called out on problem (3)	(2) See (1) above.	(2) Diagnose/remedy.
(3) Adjustment problems--won't stay set (1)	(3) Communication interruption.	(3) See (2) above.
(4) One card went out, couldn't get filament to come on--had Maintainer come (1)	(4) See (1) above.	(4) Check CCA for possible quality control problem or defect/correct.
(5) Stripped a knob (1)	(5) Inability to make adjustment.	(5) Recalibrate.
9. Amplifier (UP) Converter Assembly		
(1) Problem with UP converter (2)	(1) Communication interruption.	(1) Diagnose/remedy.

TABLE 18 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
10. DOWN Converter Assembly		
(1) DC power circuits leading to DOWN Converter hard to find, not correct. LVPS alarm in LVPS itself was only an indication but fault was not in LVPS. Raytheon took two days to get fixed--troubleshooting diagrams in TM did not help (1)	(1) Communication interruption.	(1) Modify CESE message Generator circuitry to make fault detection easier.
(2) Tuning knob slipped (1)	(2) See (1) above.	(2) Diagnose/remedy.
11. Dual RF Synthesizer		
(1) Problems with synthesizer generally not corrected by card replacement--RF coupler replaced (5)	(1) Communication interruption.	(1) Diagnose/remedy.
12. TROPO Modem Modulator		
(1) Receive/ transmit cards need to be replaced or reseated periodically (11)	(1) Communication interruption.	(1) Determine whether problems appear to be correlated with shut down/change over of generators. If so, consider putting in a phase-in switch to keep voltage constant when switching generators.

TABLE 18 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
13. TROPO Modem Demodulator		
(1) Cards need to be replaced/ reseated periodically (5)	(1) Communication interruption.	(1) Determine whether problems appear to be correlated with shut down/change over of generators. If so, consider putting in a phase-in switch to keep voltage constant when switching generators.
14. TED 1 and TED 2		
(1) Problems due to incorrect strapping by COMSEC, bad pins or too short a connecting wire to tighten down (11)	(1) Communication delay.	(1) Diagnose/remedy.
15. Low Voltage Power Supply (LVPS)		
(1) Problems noted especially when switch generators (11)	(1) Communications interruptions/ delay	(1) Introduce phase-in switch on generators to keep voltage constant when switching generators and check operational fluctuation in HZ output of generator AND/OR power down before changing generators and accept the communication interruption/delay.

TABLE 10 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
16. Low Voltage Power Supply (LVPS) (cont.)		
(2) Other problems such as bad fuse or card	(2) Communications interruption/ delay.	(2) Diagnose/remedy.
17. Base Band Patch Panel (BBPP)		
(1) Connectors behind patch panel were loose (2)	(1)-(2) Communications interruption.	(1)-(2) Diagnose/ remedy.
(2) Pins went bad (1)		
18. Loop Group Multiplexer		
(1) Problem with sufficient supply of cards (4)	(1)-(2) Communication interruption.	(1) Provide cards in Risk Kit and train/ authorize Operators to replace.
(2) Surge when changing generators necessitated a change in LGM (1)		(2) Phase-in switch for generator AND/OR shut system down when changing generators and accept communication interruption.
19. Group Modem		
(1) Problem with GM-1 in two shelters--won't pass OW data--believed to be a wiring problem (8)	(1) Could not get OW communication between shelters on GM-1.	(1)-(2) Diagnose/ remedy.

TABLE 18 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE MITIGATION
Item		
19. Group Modem (cont.)		
(2) Need to replace cards (1)	(2) Communication OW interruption between shelters.	
20. Trunk Group Multiplexer (TGM)		
(1) Replaced a bad card (2)	(1) Communication interruption.	(1) Train/authorize Operators to diagnose and correct problem from cards provided in Risk Kit.
22. AC/AC Converter		
(1) Transient problems which sometimes seem to self-correct (5)	(1)-(2) Actual or potential communication interruption.	(1) Collate data to determine whether transient problems were due to changes or fluctuations in generator output.
(2) Problems requiring repair by Raytheon (3)		(2) Diagnose/remedy.
24. Alarm Monitor (CESF Panel)		
(1) Why does monitor show a GO when you have no BER? (1)	(1) Operator is not made aware that there is a communication interruption and considerable delay could result before a problem is known to exist and acted upon.	(1) Diagnose/remedy.

TABLE 18 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
24. Alarm Monitor (CESE Panel) (cont.)		
(2) HPA not on, CESE shows no alarm until about 5 minutes later although fault light on HPA comes on (1)	(2) See (1) above.	(2) See (1) above.
(3) Summary fault lights stay on in our var. (1)	(3) Communication may be interrupted. Existence of a fault light when communication does exist creates a lack of faith in the validity of other CESE panel instructions-- analogous to a "mechanical" boy who cries wolf when there is no wolf. Even a fault indication when none exists should raise concern that electronic wiring may be defective in identifying some true fault.	(3) See (1) above.

TABLE 10 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
24. Alarm Monitor (CESE Panel) (cont.)		
(4) Configuration light on CESE panel is on even though none of seven things which cause a configuration light exist and system be operational (1)	(4) See (3) above.	(4) See (1) above.
25. Order Wire Control Unit		
(1) Electronic bridge locks up (15)	(1)-(2) Secure voice communication--needed in configuration change or reloading variable --is disrupted.	(1)-(2) Diagnose/ remedy.
(2) Problems with VINSON dropping variables (13)		
26. IF Test Panel		
(1) A frayed cable which Raytheon replaced, MAC dies not allow DS to do anything on IF Test Panel (1)	(1) Prevents internal van check out.	(1) Replace frayed cable, determine why a cable in a new piece of equipment should be frayed.
27. Heater Assembly		
(1) Heaters don't work (12)	(1) When operating in LOS and it is cold, personnel who are working in vans are cold.	(1) Inquire why in new vans, there should be so many defective heater assemblies; replace/repair as necessary.

TABLE 19 (cont.)

OBSERVATION OF OPERATORS/ MAINTAINERS	IMPACT	POSSIBLE REMEDIATION
Item		
28. Analog Voice Order Wire (AVOW)		
(1) Either can't ring other van or AVOW rings for a BY when not in use (3)	(1) AVOW malfunction--creates distracting rings at best and inability to communicate with insecure voice at worst.	(1) May indicate AVOW malfunction--check and repair as necessary.
30. Flushing Fan		
(1) Vent leaked during rain (1)	(1) Could make floor in van slippery.	(1) Diagnose/repair.
31. Remote Order Wire Control Unit (ROCU)		
(1) Problems communicating with other shelters with ROCU (8)	(1) Secure voice communication through the ROCU away from shelter sometimes not work.	(1)-(2) Diagnose/ remedy.
(2) Fault indications don't always seem accurate (1)	(2) Communication between shelters by secure ORDER WIRE may be disrupted and require Operator to remain in shelter--a risk during war.	